Curricula for Educators to Access Authentic Data and Scientific Research Experiences

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ABSTRACT AND OVERVIEW

The NASA/IPAC Teacher Archive Research Program (NITARP) allows educators (and their students) to participate in authentic astronomy research alongside professional astronomers. Teams conduct a year-long research project, from writing a proposal through presenting results at the AAS. Educators are expected to integrate their NITARP experiences into their classrooms. Some participants need additional post-program support, such as prepared curriculum elements, or a more structured on-ramp to aid in conducting authentic research-like projects with students. The BIg NITARP Alumni Project (BINAP) was formed with the goal of helping alumni with their ongoing classroom work, as well as providing materials for teachers who have not participated in the program. Members of BINAP are developing curricula for middle & high school students, as well as "Astro 101", which can help educators bring pieces of NITARP into their own classrooms. We have developed a modular set of lessons focusing on the concepts, skills, and analytical tools necessary to successfully complete a NITARP-like project. An entry-level research project, supported by the modular lessons, has also been created. It is the goal of the BINAP program to continue to add to the standalone lessons and develop additional entry-level research projects that are accessible to any interested educator.

LOCATION OF RESOURCES

The materials that have been developed have been separated into two different categories: **Standalone Lessons** and **Entry-Level Research Projects**. All materials can be found within the NITARP CoolWiki page: https://coolwiki.ipac.caltech.edu/index.php/Main_Page.

ACKNOWLEDGEMENTS

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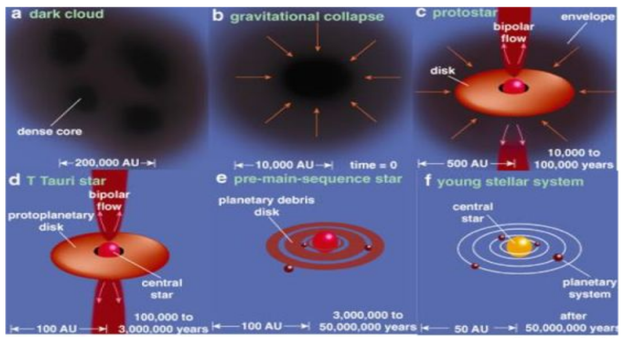
STANDALONE LESSONS

The **standalone lessons** page provides educators with a variety of resources. Nine slideshows and four classroom activities were developed to give educators and students an overview of the different concepts one might need to understand, in order to successfully complete a NITARP-type research project. There are also videos embedded within the slideshows as an additional resource. An open-source textbook as well as a lab for classifying stars have been included, though they were not developed by the BINAP team.

The modular approach of the standalone lessons provides flexibility to educators. We anticipate that some educators, including NITARP alumni, will use these materials as a review for themselves in preparation for teaching their own students. Other educators may use the standalone lessons to teach one particular concept. Still others may apply the full suite of materials to scaffold students' approach to an astronomy research project.

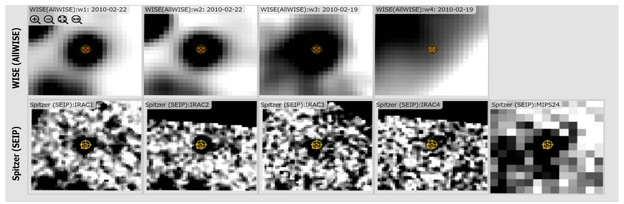
Examples of standalone lessons include slideshows, some with embedded activities, such as:

- What is a Star and How Does a Star Form?

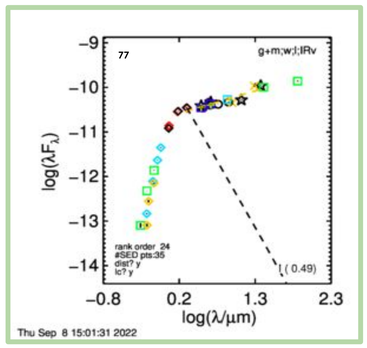


Greene, 2001

- Waves and the Electromagnetic Spectrum
- Understanding Filters
- What is a Young Stellar Object (YSO)?
- What is a Color-Color Diagram?
- Where Does the Data Come From?
- IRSA - Uploading a Catalog and Image Inspection



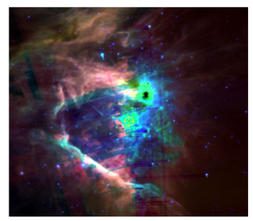
- What is a Color-Magnitude Diagram?
- What are SEDs and How to Interpret Them



Examples of standalone lessons also include classroom activities, such as:

- Creating a Color-Magnitude Diagram Using Gaia Data and IRSA
- Cracking the Color Code - a hands-on activity about color in the form of a mystery about Sharpie markers.

- Using IRSA to Make Three-Color Images



Students use the available data from IRSA to develop their own three-color image. This image of the Orion Nebula was developed using Spitzer data. Red is IRAC 4 (8 um), green is IRAC3 (5.8 um) and blue is IRAC 1 (3.6 um).

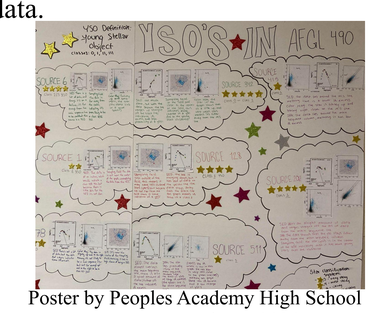
ENTRY-LEVEL RESEARCH PROJECT

The **entry-level research project** is based on research completed by multiple NITARP teams led by Dr. Luisa Rebull. Students choose a number of potential young stellar objects from IC 417 or AFGL 490. Students engage in group collaboration, analyzing the available data to determine if the object is a likely YSO.

Each source has a substantial amount of data the students will have to analyze, such as:

- Image inspection using IRSA
- SED analysis
- Color-color diagram analysis
- Color-magnitude diagram analysis
- Light curves and variability (if applicable)

The final product is a poster presentation where students work to convince their peers they have correctly identified their sources as YSOs or rejects. They will face questions from the class and should be able to defend their conclusions based on the data.



Poster by Peoples Academy High School astronomy students, 2024

PAST AND FUTURE GOALS

The BINAP team has met at Caltech with Dr. Rebull over the past two summers. The summer of 2023 was spent coming up with ideas for how to share the NITARP experience with the wider educational community. The summer of 2024 was spent developing the standalone lessons and the entry-level research project based on YSO research projects completed by Dr. Rebull's past NITARP teams.

In the future, the BINAP team is hoping to come up with more standalone lessons and another entry-level research project focused on the identification of active galactic nuclei (AGN). The activities will be based on AGN research projects completed by Dr. Varoujan Gorjian's past NITARP teams.

Ultimately the team would like to develop enough resources that an educator could reproduce a NITARP project with their students.