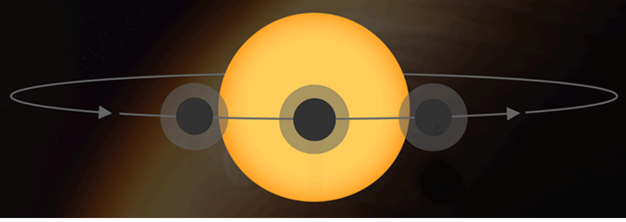


Smithsonian Data Labs

DIY PLANET SEARCH

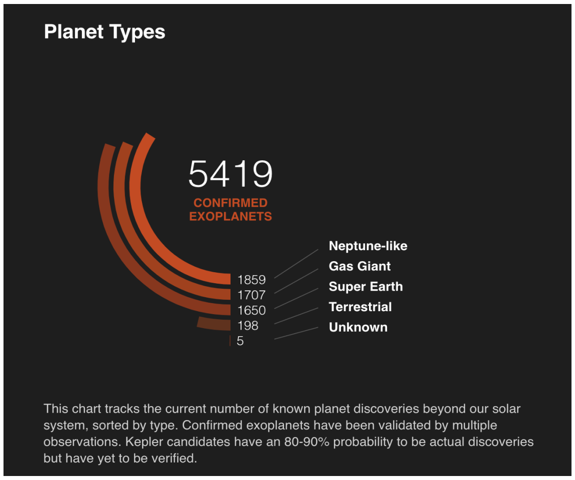
Educator Overview

You are about to involve your participants in one of the most exciting frontiers of science – the search for other worlds—and life— in solar systems beyond our own! Using the MicroObservatory telescopes, built and maintained by the Center for Astrophysics | Harvard & Smithsonian and located at the Whipple Observatory in Amado, Arizona, participants will gather real data to see if they can detect actual alien worlds orbiting distant stars. Welcome to DIY (Do It Yourself) Planet Search!

WHY THIS PROJECT?

Engages Students in Frontier Science

The *DIY Planet Search* Project engages students in the exciting scientific search to answer the age–old human question: *Are we alone in the Universe?* Central to the search for extraterrestrial life is the hunt for other Earth-like planets. Since the first extrasolar planet was discovered in the 1990s, new planets have been detected at an accelerating pace. Most of those discovered to date are much larger than Earth, closer to their stars, and therefore fiery, uninhabitable places. However, scientists expect to find more and more Earth–like worlds, orbiting just the right distance from their star, in the very near future. That means it is highly likely that this generation will be the first to find life beyond Earth.



Supports Next Generation Science Standards

DIY Planet Search aims to create a model for how to integrate content learning with the practices of authentic scientific study. The project is designed to work in a variety of physics, astronomy, and earth science classrooms. To a significant extent, you will decide your students' specific learning objectives based on the content you intend to teach. However, all students should be able to develop and consolidate their knowledge and skills in the following NGSS--recommended areas:

Disciplinary Core Ideas	Science & Engineering Practices	Cross--cutting Concepts
• Earth's Place in the Universe (ESS1.A & B) • Electromagnetic Radiation (PS4.B) • Information Technologies and Instrumentation (PS4.C)	• Asking questions • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics, information and computer technology, and computational thinking • Constructing explanations • Obtaining, evaluating and communicating information	• Size, scale, & proportion • Systems and system models • Patterns • Cause and Effect

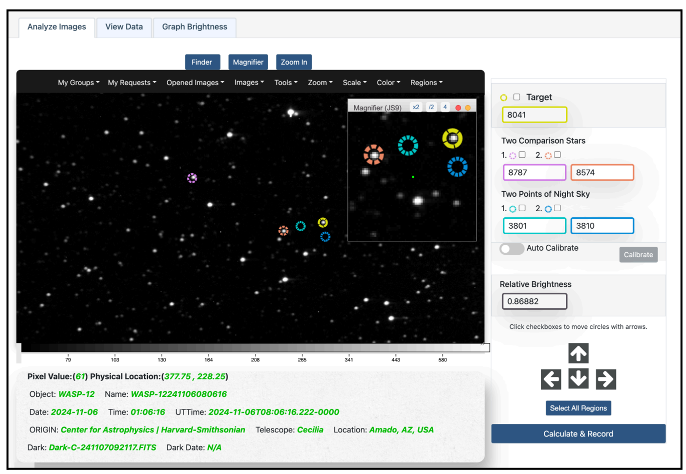
Fosters Data Literacy

DIY Planet Search is the real thing: the data that students collect are real, not canned. This means that students will learn to deal with the messiness of real data, and use the same kinds of analytical methods that professional scientists use every day to separate the *signal* from the *noise* in their investigations.

SEQUENCE OF ACTIVITIES

Time Required

This project typically requires 4 to 6 instructional hours (although some teachers have had students investigate multiple target stars to extend the project). You can start DIY Planet Search at any time, since there are exoplanets observable on practically every night of the year.



IMPORTANT: Do each step of the project once yourself before engaging students! DIY Planet Search is *real* science, including all the unexpected turns that an authentic investigation may take. You'll be much better prepared to support your students if you experience the process of analyzing telescope image data yourself first.

The core activities are outlined as follows:

Activity 1 - Introduction & Welcome to Do It Yourself Planet Search

Welcome students to the community of planet hunters. Students explore the DIY Planet Search website and share their ideas about the search for extraterrestrial life on other worlds

Activity 2 - Modeling A Transit

Using both physical and computer models, students predict the light curve of a star with an orbiting planet and consider how this model might inform their interpretation of their observational data.

Activity 3 - Scheduling Telescope Observations

Students take images of stars known to have transiting exoplanets with the MicroObservatory telescope. *Image requests should be made during the day before the scheduled Exoplanet target observations (you can go back and acquire data from past observations as well)*

Activity 4 - Image Analysis: Measuring and Graphing Brightness

Students examine their telescope images, learn how to find their target star, and take measurements of the relative brightness of their star to collaboratively create a light curve.

Activity 5 - Data Quality Analysis

Students inspect their light curve, determine if they think they see evidence for an exoplanet transit, and examine the factors that may affect the quality of their telescope image data.

Activity 6 – Data Interpretation

Students analyze the light curve using a "best fit" model to figure out the size of the planet and the nature of its orbit. Along the way they use methods for identifying a signal within noisy data, and consider how to use statistics and a modeling tool to draw conclusions from a light curve with considerable scatter.

Activity 7 - Community

This page on the DIY Planet Search website allows teachers (and the public) to post their own work, and to see the work of other schools participating in the project

Extension - The Spectrum Lab

The *Spectrum Lab* is an additional 4-6 day instructional module that engages students in light and color concepts through the use of authentic spectroscopy datasets. The module includes an activity that enables students to engage in the *characterization* of extrasolar planets. Having now discovered thousands of exoplanets, researchers at this scientific vanguard seek to glean the chemical and physical properties of these worlds, using planetary spectra to look for biosignatures.

Assessment

There are a number of opportunities throughout this project to assess students' progress. Embedded in the project are several products, which are recorded in the students' online account and can be assessed. Students are asked to make and test predictions using models and transit data they have collected and to explain their answers. Students are also asked to do mathematical calculations, the accuracy of which can be assessed. As a final assessment, you may wish to ask students to prepare a presentation, poster, or article describing their investigation, using screenshots from DIY Planet Search to illustrate their findings.

One option is to have them follow this typical format for scientific papers:

- **Title**—the subject and what aspect of the subject was studied.
- **Abstract**—summary of paper: The purpose of the investigation, the primary results, the main conclusions
- **Introduction**—*why* the study was undertaken, background
- **Methods**—*how* the study was undertaken
- **Results**—*what* was found
- **Discussion**—*why* these results could be significant (what the reasons might be for the patterns found or not found)

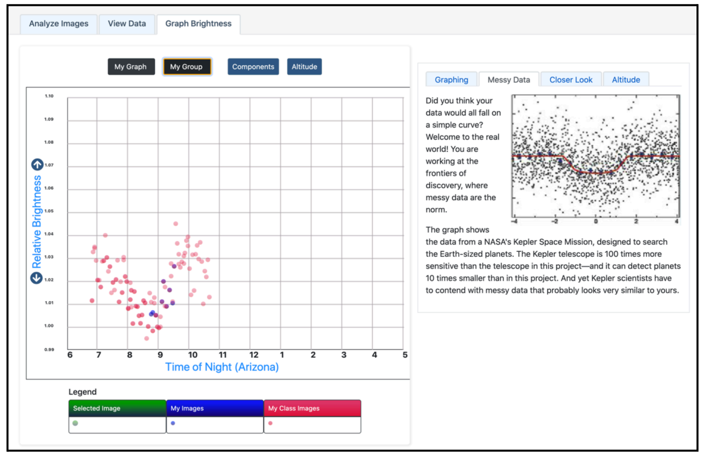
But you may also opt for more final products, such as a travel brochure to their planet, using their own imagination, their DIY Planet Search findings, plus information from NASA's [Eyes on Exoplanets](#).

BACKGROUND SCIENCE

Detecting Extrasolar Planets via the "Transit Method"

Astronomers have been hunting for planets that orbit stars similar to our own Sun. To date, they have confirmed detections of nearly 5400 of these new worlds (for the latest numbers, go to https://exoplanets.nasa.gov/). Only in very rare circumstances can astronomers use current telescopes to detect these planets directly. Instead, astronomers use indirect methods. One such method, used here in DIY Planet Search, involves detecting a planetary transit.

In a few cases, the orbit of an alien planet happens to be oriented so that the planet passes through our line of sight with the star. That is, the planet eclipses, or blocks, part of the star's light; once during each orbit. These are called transiting planets, because if we were closer we would see the planet transit across the face of the star.



How Can a Telescope be Used to Detect Planetary Transits?

Telescopes do more than take pictures – they gather light; and the images contain valuable information about the amount of light reaching the telescope from each star. It turns out that even a small telescope, such as the MicroObservatory telescope students will be using, is sensitive enough to detect a 2--3% drop in the amount of light reaching the telescope when the image is taken. To detect a transiting planet, you must take a series of images that span the timeframe of the entire transit; measure the brightness of the star in each of those images; plot it on a graph of time versus brightness; and look for the telltale dip in brightness that is the signal of the alien world.

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