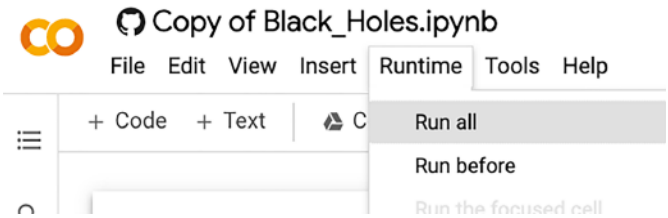
Student Worksheet for the Backyard Worlds: Brown Dwarfs Instant Pack

In this activity we'll explore a bit of the physics, astronomy and math behind how we can discover new nearby neighbors of the Sun referred to as brown dwarfs. Then we'll look through some telescope data to identify real brown dwarfs hidden among other stars, galaxies and detector noise. This activity is conducted in a Python Notebook, a web-based interactive computational environment that contains code, text, and plots.



Pre-Activity Setup: Go to the 'Runtime' menu and select the option to 'Run all'. Running all helps to ensure a cell was not skipped and all libraries are imported to help the activities work properly. As you work through the Python Notebook, you may also re-run each cell individually.

Activity 1: Motions of Stars and Brown Dwarfs
Look at the apparent motion of Barnard's Star in the first sky patch.

1. Why don't we see the motion of Barnard's Star using the slider with 100-year time increments in the second sky patch?

2. After a long time (millions of years), all the stars in this visualization 'go away'. If we were to actually look at a patch of sky for millions of years, would all the stars go away?

Activity 2: Colors of Stars and Brown Dwarfs
The plots in this section illustrate how the color of a star shifts from blue to red as you go from the hottest stars (temperature ~ 50,000 kelvins) to cold brown dwarfs (temperature = 700 kelvins). The transition from star to brown dwarf happens at roughly 2,200 kelvins.

Activity 2.1: Looking for Brown Dwarfs Based on Motion and Color

In this section, observe how Backyard Worlds uses motion and color to discover new brown dwarfs.

3. The second animation shows a brown dwarf discovered by Backyard Worlds citizen scientists in April 2018. Which direction do you see the brown dwarf moving over time?

Activity 3: Discover the Brown Dwarf Candidates

Use the Google Sheet to discover brown dwarf candidates. Please make a copy of this Google Sheet by clicking the blue "Use Template" button. The candidate in each case is at the center of the field of view (but keep your eyes out for celestial objects that might be moving in other parts of each movie!).

Collaborate with your team to fill out the NOTES column about whether each candidate is a brown dwarf or not.