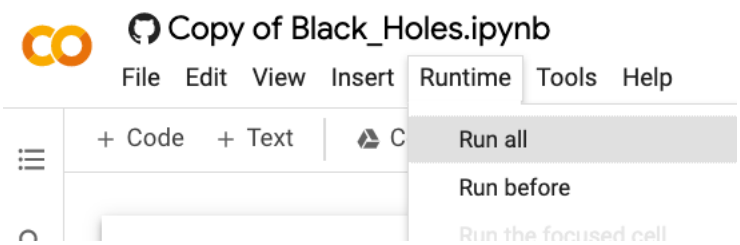
Student Worksheet for the Black Holes Instant Pack

Black holes are astronomical objects that exert an extreme force of gravity due to their very high density and/or mass. In this activity, you will explore the different kinds of black holes and learn how the largest black holes might change the fate of the galaxies they live in. 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: What are Black Holes?

If we cannot see black holes, how do scientists discover them? In this section, you will learn what a black hole is and how scientists are able to detect them.

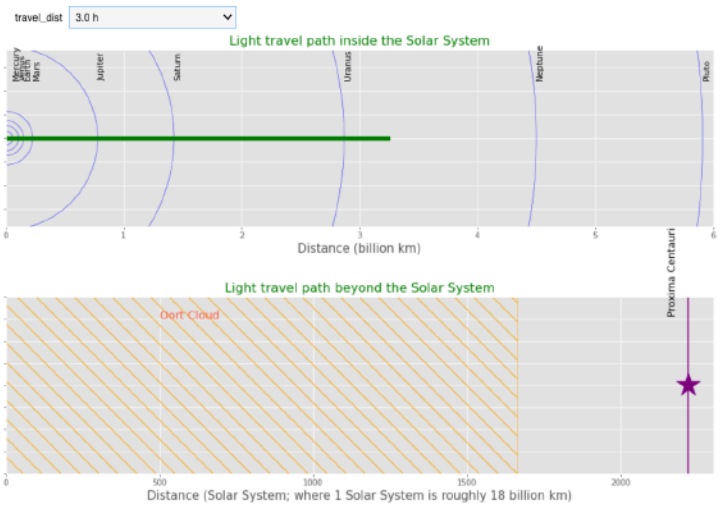
1. How do you think astronomers measure the size of something that we cannot reach nor zoom-in to observe in detail?

Activity 1.1: Using Light to Measure Sizes

In this section, you run a cell to calculate the speed of light using different units.

Activity 1.2: Light Travel Distances Relative to the Solar System

In this section, you will create an interactive plot to visualize light travel distances in the Solar System. Use the interactive plot to answer the following questions.

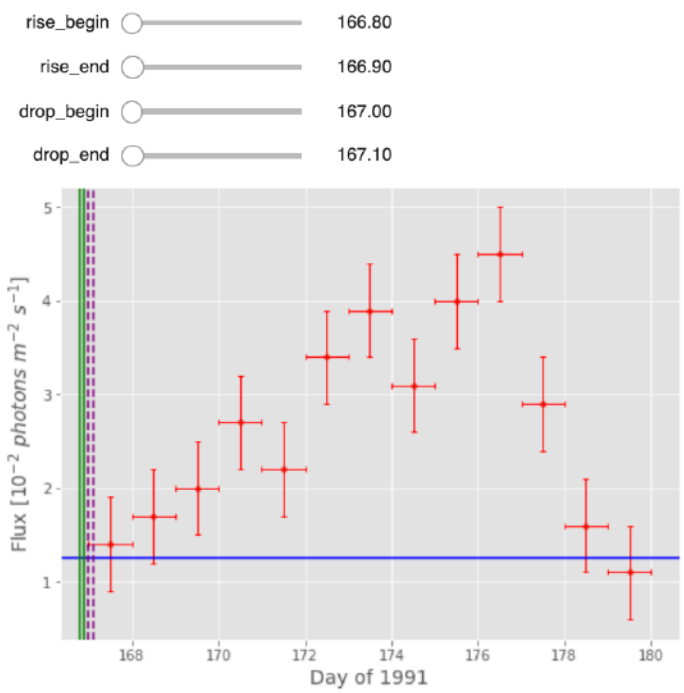


2. How far does light travel in 8 minutes?

3. For how long does light need to travel to reach all the way to the orbit of Pluto?

Activity 2: How Big is the Flare of 3C 279?

This section uses real data from the 3C 279 quasar to plot a photon flux in order to determine how long the flare lasted.



Activity 2.1: Light-Year as a Distance

In this section, you will run a cell to determine the distance light travels in one week.

Activity 2.2: Let's Look at Some Real Data!

Here you will use a photon flux plot to compute the rising and falling times of the flare.

4. How long did the flare last?

*Be sure to enter the shorter rise or fall time in the cell to compute the size of the flare.

5. How large is the flare relative to the size of the Solar System?

6. Do you expect it to be larger or smaller, and why?

Activity 3: How Much Energy is in the Flare?

In this activity, you will calculate the energy emitted in the flare and compare it to the energy of the Sun and of a galaxy.

7. How bright is the flare at maximum in terms of photon flux?

Activity 3.1: Convert from photon Flux to Luminosity

8. How much energy does the flare emit relative to the Sun?

9. Do you expect it to be more or less, and why?

10. How many years would it take for the Sun to produce the same amount of energy as the flare in one second?

11. How much energy does the flare emit relative to the entire Milky Way galaxy?

12. Do you expect it to be more or less, and why?

Conclusion: How Can Black Holes Change the Fate of Galaxies?

13. What do you think could happen to galaxies when their central black hole produces an active galactic nucleus? An energetic flare?