Black Holes

Disciplinary Core Ideas

PS2.B 6-8: Types of interactions

- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small unless one or more of the objects have very large masses -e.g., earth and the sun.
- Forces that act at distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effects on a test object (a charged object, or a ball, respectively).

ESS1.A 3-5: Universe and its stars

- The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.
- (HS) Other than the Hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releasing electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

PS1.C 9-12: Nuclear Processes

- Nuclear process, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.

PS3.D 9-12: Nuclear Processes

- Nuclear Fusion processes in the center of the sun release energy that ultimately reaches Earth as radiation.

Activities

Journey to a Black Hole

Grades 5-6

"Journey to a Black Hole" is a demonstration manual that contains many fun and useful activities for developing a deeper understanding of black holes. Many of these demonstrations are best for grades 5-6, though there are several which could extend to higher grade levels (at the instructor's discretion). The activities that we have chosen to highlight include: 6. Modeling a Black Hole (page 19), 8. Black Holes Hide and Seek (page 29), and 9. Black Holes Lensing (page 32).

Harvard-Smithsonian Center for Astrophysics (2008). Journey to a Black Hole. *Educational Resources,* Retrieved from https://www.cfa.harvard.edu/seuforum/einstein/resources/JourneyBlackHole/JourneyBlackHoleManual.pdf

What if There Were a Black Hole in Your Pocket?

Grades: 7-12 (potentially 6th as well if they have just had a unit on mass)

Kurzgesagt's Video 'What if There Were a Black Hole in Your Pocket?' takes viewers through a thought experiment on the power of Black Holes. This video is especially useful for any students who struggle with the concept of mass vs size or diameter. If students already have a basic knowledge of black holes, have them hypothesize an answer to the two scenarios presented before finishing the video.

Kurzgesagt (2015, July 16). Retrieved August 25, 2017, from https://www.youtube.com/watch?v=8nHBGFKLHZQ

Resources for Further Learning

What is a Black Hole?

Grades 5-8

NASA provides a good introduction to the concept of black holes. This can be used either before or after your class has seen our program.

Dunbar, B. (2015, June 01). What Is a Black Hole? Retrieved August 25, 2017, from https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-black-hole-58.html

The Event Horizon Telescope

Grades 9-12

One relevant look at the current study of black holes comes from the Event Horizon Telescope project. This is a joint project between multiple telescopes and observatories across the globe with the goal of compiling an image of the black hole at the center of our own Milky Way galaxy. Their website contains information regarding their progress processing the data they have gathered.

Event Horizon Telescope. (n.d.). Retrieved August 25, 2017, from http://eventhorizontelescope.org/

Black Holes Explained-From Birth to Death

Grades: 5-12

Kurzgesagt's Video 'Black Holes Explained-From Birth to Death.' simplifies some of the concepts addressed in Clark Planetarium's production of 'Black Holes'. This can be a brief overview post viewing should student's need to revisit the material.

Kurzgesagt (2015, December 15). Retrieved August 25, 2017, from https://www.youtube.com/watch?v=e-P5IFTqB98