

This guide is meant to be a supplement for teachers bringing their students to the live Planetarium show **Explore the Galaxy** at the Museum of Science, Boston. The suggested grade levels for this show are **grades 6 – 12**. Reservations can be made by calling Science Central: 617-723-2500.



Contained in this guide are:

- Show summary
- Exhibit connections
- Connections to educational standards
- Useful vocabulary
- Suggestions for outside exploration

Show Summary

A typical **Explore the Galaxy** show begins on the Earth, examining several constellations, planets, and stars of interest visible in the night sky. The show then progresses through the solar system, discussing the planets, moons, asteroids, comets and dwarf planets and their properties. Outside the solar system, interstellar space and phenomena like nebulae, star clusters, and exoplanets are explored. On a larger scale, we discuss the Milky Way Galaxy and its major components, such as the spiral arms, central bar, and supermassive black hole. High school students might delve deeper to explore intergalactic space and the structure of the visible universe. Emphasis is placed on interaction with the presenter, and the immersive nature of the show attempts to deliver an understanding of more abstract concepts such as scale and scope.

Exhibit Connections

If you plan to tour the museum exhibit halls during your visit, there are plenty of opportunities related to space. You may want to check out:

- Cosmic Light: <http://www.mos.org/exhibits/cosmic-light>
- Earth & Space Exploration: <http://www.mos.org/live-presentations/earth-and-space-exploration>
- To The Moon: <http://www.mos.org/exhibits/to-the-moon>
- The Light House: <http://www.mos.org/exhibits/light-house>

Connections to Education Standards

The educational standards typically discussed in this show are listed below. However, the Planetarium educators may be able to accommodate additional specific topics you may be discussing with your students. To request these special topics, you must email schoolplanetarium@mos.org with at least 2 weeks advance notice.

Next Generation Science Standards:

- Earth's Place in the Universe
 - MS-ESS1-1; MS-ESS1-2; HS-ESS1-2; HS-ESS1-3; HS-ESS1-4
- Earth's Systems
 - MS-ESS2-2
- Motion and Stability: Forces and Interactions
 - MS-PS2-4; MS-PS4-5; HS-PS2-4
- Waves and Their Applications in Technologies for Information Transfer
 - MS-PS4-2; HS-PS4-1

2016 Massachusetts Science and Technology/Engineering Curriculum Framework:

- Earth's Place in the Universe
 - 6.MS-ESS1-1a; 6.MS-ESS1-5(MA); 8.MS-ESS1-2; HS-ESS1-1; HS-ESS1-2
- Motion and Stability: Forces and Interactions
 - 6.MS-PS2-4; 7.MS-PS2-5; HS-PS2-4
- Waves and their Applications in Technologies for Information Transfer
 - 6.MS-PS4-2; HS-PS4-1

Vocabulary

Black Hole- A region of space where mass is so highly concentrated that the gravitational pull becomes incredibly strong. Within a certain distance from the black hole, called the *event horizon*, nothing, not even light, is fast enough to escape the gravitational pull. *Stellar* black holes are left behind after the collapse of a very massive star (10 to 15 times the mass of the Sun). *Supermassive* black holes are thought to exist at the centers of most galaxies, and are much more massive than stellar black holes (on the order of hundreds of thousands to billions of times the mass of the Sun).

Dwarf Planet- An object that (a) orbits the Sun and (b) has sufficient mass to assume a nearly round shape, but (c) may orbit in a zone that has other objects in it. There are currently five accepted dwarf planets: Ceres, Pluto, Eris, Makemake, and Haumea.

Exoplanet- A planet found orbiting a star outside our solar system. In some cases, more than one exoplanet is found orbiting the same star, making it part of a multiple planetary system.

Galaxy- A collection of billions of stars, gas, and dust, all held together by gravity. Our Milky Way Galaxy is *spiral* in shape and name. Some galaxies are called *elliptical* and are spherical in shape, while others are called *irregular* and have shapes very difficult to classify. The closest spiral galaxy to the Milky Way is the Andromeda Galaxy, almost 2.5 million light years away.

Light Year- A light year is the distance light can travel in a vacuum in one Earth year – roughly equivalent to 6 trillion miles. We use this measurement for objects in space because distances are too great to measure by conventional means.

Nebula- An interstellar cloud of dust and gas (predominantly hydrogen and helium). Nebulae are commonly thought of as places where stars and planets are being actively formed, but they can also describe other astronomical phenomena. A *planetary nebula* is the gaseous shell released upon the death of a low mass star. *Supernova remnants*, the gas thrown out from an exploding, high mass star, are also sometimes referred to as nebulae (for example, the Crab Nebula).

Neutron Star- The dense remnant left behind after the collapse of a very massive star (between 4 to 8 times the mass of the Sun). The outer layers of the star are blown out into space as the star explodes in a *supernova*, leaving behind only the central region of the original star. This central region collapses in on itself due to gravity, so much so that the protons and electrons are forced together to become neutrons.

Planet- A celestial body that (a) orbits a star, (b) has sufficient mass to assume a nearly round shape, and (c) has cleared the neighborhood around its orbit, which means it is free of other large objects.

Radio Sphere- The boundary of radio transmissions sent from Earth into space, distributed uniformly in a spherical shape with Earth at the center. The earliest signals with enough power to escape the Earth were broadcast in the mid-1930s, and all subsequent signals will continue to extend out into space at the speed of light. Because they have traveled much faster and farther than any spacecraft, these radio transmissions mark the farthest influence of humanity in the Galaxy. The current radius of the radio sphere is approximately 75 light years.

Solar System- A collection of objects, such as planets, dwarf planets, moons, asteroids, and comets that orbit a star. “Solar system” also refers to our own planetary system, orbiting the Sun.

Supergiant- These are the most massive types of stars, ranging from 10 to 70 times the mass of the Sun. Their extreme mass typically means their lifetimes are short, lasting anywhere from only a few hundred thousand years to 30 million years. When these stars have reached the end of their lives, they typically explode in a supernova, leaving behind either a neutron star or a black hole.

Star Cluster- A group of stars that share a common origin (nebula) and are bound by gravity to one another. There are 2 types of clusters: 1) *Globular* clusters are roughly spherical in shape and contain between 10,000 to several million very old stars; 2) *Open* clusters generally contain younger stars and are less tightly-bound than globular clusters, containing only a few hundred stars.

Supernova- The explosion and internal collapse of a very massive star (greater than 4 times the mass of the Sun) at the end of its life.

White Dwarf- The incredibly dense remnant of a star of low or medium mass (roughly 0.07 to 10 times the mass of the Sun). After a star has burned through its hydrogen supply, a star of this size will shed its outer layers as a planetary nebula, leaving the dense core behind, which will become the white dwarf. This core will cool off slowly over time to become a *black dwarf*, at which point it would no longer radiate heat or light.

Suggestions for Outside Exploration

Below are some links and suggested activities to support your field trip to the Planetarium.

Build Your Own Star – Virtual Experiment: A simulator exploring different types of stars and allowing students to create and observe their own star over its lifetime.

<http://www.planetseed.com/laboratory/virtual-experiment-build-your-own-star>

Cool Cosmos: Find lesson plans, galleries, and more information on infrared astronomy.

http://coolcosmos.ipac.caltech.edu/education_resources

Cracking Up: Plate Tectonics, Volcanism, and the Structure of the Earth: A series of links to activities and information related to plate tectonics and rock processes.

<http://www.lpi.usra.edu/education/workshops/plateTectonics/>

Making Waves with the Electromagnetic Spectrum: Lessons and materials recommended for grades 9-12.

http://www.pbslearningmedia.org/resource/phy03.sci.phys.energy.lp_emspect/making-waves-with-the-electromagnetic-spectrum/

Observatories Across the Electromagnetic Spectrum: Information about different observatories and a link to an app that allows you to build your own satellite.

http://imagine.gsfc.nasa.gov/science/toolbox/emspectrum_observatories1.html

The Expanding Universe: Lesson plans and activities related to the Big Bang theory and the expansion of the universe.

<https://btc.montana.edu/ceres/html/Universe/uni1.html#activity2>

What Is Microgravity? Explains the existence of gravity in space, along with links to activities.

<http://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-microgravity-58.html>