- **imagine.gsfc.nasa.gov/**
  "Imagine the Universe!" is a site designed for teenagers to explore the mysteries of the structure and evolution of the Universe. It includes lesson plans, activities and more.
- **amazing-space.stsci.edu/whatsnew.shtml**
  "Amazing Space" contains a wealth of online activities and the latest news and images directly from deep space!
- **chandra.harvard.edu/field_guide.html**
  This site from the Chandra X-ray Observatory contains a wealth of information, including a star field guide, interactive games and printable materials for classroom use.

## Suggested Print Resources


- Kaufmann, William J. *Universe: Stars and Galaxies.* Freeman and Company, New York, NY; 2001.
- Kirshner, Robert. *The Extravagant Universe: Exploding Stars, Dark Energy, and the Accelerating Cosmos.* Princeton University Press, Princeton, NJ; 2002.
- Rees, Martin. *Before the Beginning: Our Universe and Others.* Perseus Publishing, Cambridge, MA; 1998.
- Tucker Wallace. *Revealing the Universe: The Making of the Chandra X-ray Observatory.* Harvard University Press, Cambridge, MA; 2001.



**TEACHER'S GUIDE**

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TEACHER'S GUIDE

COSMIC ODYSSEY

# Stellar Evolution

### Lives of the Stars

## Grades 9–12

This series tells the stories behind the science of astronomy in an informative and entertaining way. Fast-paced and visually rich, viewers journey to exotic destinations within our solar system from moons and planets to comets and asteroids. Featuring advances in scientific investigation, this series investigates cosmic mysteries including the birth and death of stars, the structure of the universe, and the search for extraterrestrial life.

This guide provides a brief synopsis of the program, background on the science concepts presented in the show, discussion topics, activities, vocabulary and additional resources.

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## Program Summary

If we could watch for millions of years, we'd see the stars go through an astonishing sequence of changes. We would observe that stars are born and that they eventually die. With just a glance at the night sky you can see some of these stages for yourself. Scientists who study the lives of the stars have determined that in about five billion years, our sun will gradually begin to exhaust its nuclear fuel. It will initially expand out to a red giant star and then its outer layers will explode into space, leaving only the hot core of the sun at the center.

The theory behind star formation is straightforward. A clump of hydrogen gas collapses under the force of gravity until it gets so small and so hot, nuclear reactions are triggered, and the new star begins to shine. Thanks to the predictions of stellar evolutionary theory, astronomers are able to date stars based on their colors. In general, blue hot stars are the energetic youngsters of the galaxy, while red cool stars are older suns in their declining years.

Astronomers are finding ways to observe star formation by employing a telescopic "ultrasound" — a camera sensitive to infrared light — to monitor incubating stars before they are born. They are also learning what happens to stars after they die. For example, a star about the size of our sun shrivels to an Earth-sized white dwarf whose interior is crushed so severely that it is composed literally of diamonds. During its demise, the star expels a multicolored cloud of gas called a planetary nebula. The cosmic smoke rings are among the galaxy's most astonishingly beautiful objects. A more massive star will suffer a spellbinding supernova explosion, then collapse into a superdense, city-sized object that spins many times per second. This whirling neutron bomb, called a pulsar, ejects twin beams of high-energy radiation detected thousands of light years away on Earth. The ultimate dead-end for the heftiest stars is a black hole, an object from which no light can escape. Inside a black hole, time and space as we know them cease to exist.

## Vocabulary

**black hole —** A dense, compact object whose gravitational pull is so strong that — within a certain distance of it — nothing can escape, not even light. Black holes are thought to result from the collapse of certain very massive stars at the ends of their evolution.

**elements —** The fundamental kinds of atoms that make up the building blocks of matter, which are each shown on the periodic table of the elements. The most abundant elements in the universe are hydrogen and helium.

**fusion —** The process in which atomic nuclei collide so fast that they stick together and emit a large amount of energy. In the center of most stars, hydrogen fuses into helium. The energy emitted by fusion supports the star's enormous mass from collapsing in on itself and causes the star to glow.

**Galactic Plane Survey —** A project developed by a group of radio astronomers who scan the Milky Way at a certain radio frequency. Pooling their data, they are able to observe objects that cannot be seen any other way.

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**hydrogen —** The lightest and most abundant element. A hydrogen atom consists of one proton and one electron.

**helium —** The second lightest and second most abundant element. The typical helium atom consists of a nucleus of two protons and two neutrons surrounded by two electrons.

**matter —** Substances made predominantly of atoms consisting of protons, neutrons and electrons. Matter can exist in four states: solid, liquid, gas or plasma.

**Milky Way —** The spiral galaxy in which our solar system resides, along with a few hundred billion stars.

**nebula —** An interstellar cloud of gas and dust.

**pulsar —** A rotating neutron star which generates regular pulses of radiation.

**red giant —** A star that has low surface temperature and a diameter that is large relative to our sun.

**supernova —** The explosive death of a star. One of the most energetic events of the universe, a supernova may temporarily outshine the rest of the galaxy in which it resides.

**SWAS —** (Submillimeter Wave Astronomy Satellite) An Earth-orbiting radio telescope designed to look for water and oxygen molecules in distant star-forming regions of the universe.

**quasars —** Distant, highly luminous clouds that surround black holes.

**white dwarf —** A star that has exhausted most or all of its nuclear fuel and has collapsed to a very small size.

**X-rays —** Invisible electromagnetic radiation with wavelengths shorter than visible light. X-rays are produced when high-energy charged particles collide with other charged particles or with atoms.

## Activities & Discussion

- Will our sun end in a supernova? Why or why not?
- From where has most of the nitrogen on Earth come?
- Provide students with images of nebulae from the Hubble Space Telescope like the Helix, Ring, Eskimo, Spirograph, Twin Jet, Ant, Cat's Eye and Crab. Ask them to choose their favorites to research and report back to the class. Make sure the students provide information on the equipment used to observe the events and images of 'their' cosmic events.

## Suggested Internet Resources

Periodically, Internet Resources are updated on our Web site at www.LibraryVideo.com

- **www-spof.gsfc.nasa.gov/stargaze/Sintro.htm**
  *From Stargazers to Starships* deals with the world of gravity, massive planets, and stars, and the way spaceflight is achieved despite their strong pull. The material is suitable for high school students and gives historical background as well as the latest scientific findings.

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