- **chandra.harvard.edu/xray_sources/blackholes.html**
  This site from the Chandra X-ray Observatory contains a wealth of information, including an overview of X-ray astronomy, interactive games and printable materials for classroom use.
- **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.

Suggested Print Resources

- Gott, J. Richard. *Time Travel in Einstein's Universe.* Houghton-Mifflin, New York, NY; 2001.
- Gribbin, John. *In Search of the Edge of Time: Black Holes, White Holes, Wormholes.* Crown Publishing, New York, NY; 1999.
- Hawking, Steven. *The Universe in a Nutshell.* Bantam Doubleday Dell, 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

Extreme Astronomy

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

Invisible energy rays turn out to be surprisingly important for life on Earth. They're one of the main sources of genetic mutations. Without mutations, evolution would be impossible, so in a way, we owe our existence to these mysterious, high-energy bullets from somewhere in deep space. A major challenge for scientists has been figuring out how to measure these invisible energy sources.

"High-energy" radiation includes X-rays, gamma rays, and cosmic rays. Although they pass through the human body well enough to be medically useful, X-rays have trouble traveling through even a small amount of air. When scientists wanted to find out if anything in space was emitting X-rays, they had to wait until they could launch X-ray telescopes into space. For that matter, they had to figure out how to build an X-ray telescope in the first place. It's a major challenge to gather and focus radiation to go right through the instrument without stopping. But the challenge was met, and so was the even tougher task of constructing gamma-ray satellites.

X-rays and their even higher-energy cousins, gamma rays, are the alarm signals of atoms in extreme distress. Nature doesn't usually produce these kinds of radiation unless temperatures of millions of degrees are involved. So high-energy radiation alerts us to the rare but spectacular catastrophes of the universe: supernovas, stars in collision and planets falling into black holes. Using telescopes that can see deep enough into space, astronomers have found that there is a surprisingly large amount of that sort of thing going on! Even the sun takes on a bizarre and sinister appearance when seen by the light of its own X-rays, but it's the colliding galaxies, exploding suns and other deep-space cataclysms that are the true amazing objects of high-energy astronomy.

A new generation of X-ray and gamma ray telescopes is being designed in the hope of learning more our universes, including the mysterious origin of cosmic rays. They are atomic nuclei that fly through space at almost the speed of light, and they hit the atmosphere so hard the resulting flash can be picked up from ground level by special receivers.

Vocabulary

antimatter — Matter composed of particles with opposite charges and magnetic fields as the subatomic particles found in ordinary matter. When antimatter joins its counterpart, mutual annihilation occurs.

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.

cosmic rays — Energy in the form of atomic nuclei that fly through space at almost the speed of light.

electron — A negatively charged particle commonly found in the outer layers of atoms.

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.

FUSE — (Far Ultraviolet Spectroscopic Explorer) An orbiting telescope that studies galaxies by looking at ultraviolet energy.

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gamma ray — A region of the electromagnetic spectrum, beyond X-rays, corresponding to radiation of very high frequency and very short wavelength.

gamma ray burst — An outburst that radiates tremendous amounts of energy equal to or greater than a supernova, in the form of gamma rays and X-rays.

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

nebula — An interstellar cloud of gas and dust.

photon — The smallest unit of light/electromagnetic energy. Photons are generally regarded as particles with zero mass and no electric charge.

radiation — Energy emitted in the form of waves (light) or particles (photons).

spectrograph — An instrument that breaks up light for analysis.

spectroscopy — The study of the way in which atoms absorb and emit electromagnetic radiation. Spectroscopy allows astronomers to determine the chemical composition of stars.

supernova — 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.

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

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

- What is an X-ray telescope? How does it differ from other types of telescopes? Why can't you observe X-rays from the ground?
- Ask students to define the following: black hole, supernova, quasar, gamma ray, nebula.
- Provide students with images of nebulae and other cosmic events from the Hubble Space Telescope. Ask them to choose their favorite to research and report back to the class.

Suggested Internet Resources

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

- **amazing-space.stsci.edu/whatsnew.shtml**
  "Amazing Space" contains a wealth of online activities and the latest news and images directly from deep space!
- **science.nasa.gov/headlines/y2003/04mar_xrayteachers.htm**
  This site gives teachers background information on black holes and other high energy astronomy topics, along with activities and links to other resources.
- **spaceplace.jpl.nasa.gov/st5xband/st5xband.html**
  This NASA site explains how energy from outer space is analyzed with computers on Earth.

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