- **www.stsci.edu/resources/**
  The Space Telescope Science Institute provides a great deal of information on the latest cosmic observations and their implications.
- **csep10.phys.utk.edu/guidry/violence/violence-root.html**
  "Violence in the Cosmos" explains how modern astronomy is revealing how our universe evolved.
- **chandra.harvard.edu/xray_astro/dark_matter2.html**
  This site from the Chandra X-ray Observatory contains a wealth of information, including an overview of the dark matter mystery, interactive games and printable materials for classroom use.

Suggested Print Resources

- Gott, J. Richard. *Time Travel in Einstein's Universe.* Houghton-Mifflin, New York, NY; 2001.
- 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.

TEACHER'S GUIDE

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- **21ST CENTURY COSMOS**
- **THE CASE FOR MARS**
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TEACHER'S GUIDE

21st Century Cosmos

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

In less than one hundred years years, our perception of the scale of the cosmos has changed radically from a starry realm the size of the Milky Way to an expanding space-time of countless galaxies. Yet mysteries remain. We still crave to know about the origin and fate of the universe.

The questions of cosmology come easily to anyone who has gazed in awe at a star-filled night sky: How old is the universe? When did it come into being? How big is it? How will it end? Scientists feel that they are on the verge of getting some answers. For example, an international team of astronomers has used the Hubble Space Telescope to make significant refinements to their estimates of the distances and recession speeds of galaxies. Typically, any explosions we know about slow down over time until all the energy dissipates. But apparently, with the universe itself, it's the other way around. The universe is accelerating with time, rather than decelerating as had been expected! The galaxies are flying apart from each other faster and faster as time goes on.

The universe is so large, our place in it so small and our understanding of it is limited. The cosmos abounds with mysteries, yet the clues to solve them are out there, too.

On another front, the Hubble Space Telescope has provided spectacular views of star systems in collision. This process may explain what led to the formation of the first galaxies billions of years ago.

Scientists use other modern instruments to map tiny variations in the temperature of the cosmic microwave background — the remnants of the Big Bang. The size of these "ripples in space-time" is consistent with predictions that the geometry of space is flat — not curved. Theory states that a flat universe will expand forever. According to the latest observations, a strange "vacuum energy" between the galaxies is indeed pushing along the cosmic expansion. But how did the universe flatten out in the first instant of its existence?

Many questions still nag at scientists. For example, how much matter and energy does the universe contain? The flat universe model is quite specific on this issue. Astronomers say that they can't begin to account for the desired total from their observations of stars and gas alone. They propose that the universe is filled with something called "dark matter" — but of what is it made? The thrill of discovery awaits us around every corner.

Vocabulary

baryons — Heavy subatomic particles, such as protons and neutrons, that make up the nuclei of atoms.

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.

Big Bang — The dominant scientific theory about the origin of the universe. According to the big bang, the universe was created sometime between 10 billion and 20 billion years ago from a cosmic explosion that hurled matter and in all directions.

COBE experiment — A NASA mission launched in 1989 to measure background radiation from the Big Bang.

cosmological constant — Also called cosmic repulsion force, vacuum energy, false vacuum energy and dark energy. A modification of the equations of general relativity that represents a possible repulsive force that opposes gravity in the universe.

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cosmology — The study of the origin and evolution of the universe.

dark matter — Matter that cannot be observed by radio, infrared, optical, ultraviolet, X-ray, or gamma-ray telescopes.

galaxy — A group of hundreds of millions of stars, other objects, gas and dust that is held together in space by gravity. Telescopes such as the HST have revealed billions of galaxies other than our own.

gravity — The force of attraction of every body to every other body due to the masses of each body.

Edwin Powell Hubble — (1889-1953 CE) An American astronomer who discovered the existence of other galaxies moving away from one another in 1924, leading to the conclusion that the universe is expanding.

Hubble's Constant — The mathematical constant that gives the relationship between the velocity of receding galaxies and their distance.

Hubble Space Telescope — The first large optical telescope launched above the Earth's atmosphere carrying instruments sensitive to visible and ultraviolet light. The telescope was built by NASA with major contributions from the European Space Agency, and was launched in 1990.

"inflationary universe" — Theory of a kind of struggle between two almost-balanced forces proposed in the 1970s primarily by Alan Guth of M.I.T that gives a reason for the Big Bang. Gravity tries to pull everything together, while the cosmic repulsion force attempts to blow everything apart.

NASA — Acronym for the National Aeronautics and Space Administration, a U.S. government agency formed in 1958 with the goal of making space exploration possible

spectrum — All the different wavelengths of electromagnetic radiation, including light, radio waves, and X-rays. It is a continuum of wavelengths from zero to infinity.

standard candle — Any object with an easily recognizable appearance and known luminosity, which can be used in estimating distances. Supernovae are good examples of standard candles and are used to determine distances to other galaxies.

Activities & Discussion

- Ask students to consider gravity. Using a soft, thick foam pad and a number of weighted balls, have them place the balls of different weights in different areas of the foam and observe how the other balls react in relation to each other.
- Why was the "Boomerang" experiment performed at the South Pole?
- Have students research the story of Albert Einstein's development and consequent discarding of the "cosmological constant."

Suggested Internet Resources

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

- **cfa-www.harvard.edu/seuforum/**
  Harvard's "Universe!" Web site includes a variety of interactive tools and other educational resources for exploring space, time and matter.

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