

Radio and Space Telescopes

The background of the slide features several thick, light gray, wavy lines that flow from the bottom right towards the center, creating a sense of movement and depth.

Space Telescopes

- By placing telescopes in space, astronomers could break free of the distorting and shielding effects of the Earth's atmosphere
- Space telescopes can study the universe in many different types of light, and record details that could never be observed from Earth
- Space telescopes give humanity the clearest view of the universe

The Drawbacks of Space Telescopes

- They're much more expensive to build and launch than ground-based observatories
- Because they must be launched into space, they can't be as large as ground-based observatories
- Because space telescopes remain in orbit, fixing and upgrading them can be either difficult or impossible. When they eventually break down, they're gone forever

NASA's Space Telescopes

- NASA's Great Observatories program constructed four orbiting telescopes — the Hubble Space Telescope, the Compton Gamma Ray Observatory, the Chandra X-ray Observatory, and the Spitzer Space Telescope
- Other space telescopes, like the James Webb Space Telescope, are being planned and built

COBE

- Cosmic Background Explorer
- Launched in 1989
- Orbited at 547 miles above Earth
- Studies the faint infrared and microwave radiation from the early universe called cosmic background radiation
- Scientists believe this radiation is left over from the Big Bang
- Used solar panels to collect light from the Sun for energy, and a funnel-shaped sunshade to keep the light from shining on and heating the cold parts of the satellite
- In addition, liquid hydrogen helped keep the telescope cool
- COBE had to stay extremely cold because it was studying infrared light, or heat
- Unless the satellite and its detector could be kept cool, it would give off infrared signals of its own that would interfere with the infrared signals it was trying to detect



COBE Discoveries

- Scientists used the information collected by COBE to create maps of the sky in infrared and microwave radiation
- They discovered that the cosmic background radiation isn't all the same
 - It seems to be lumpy — a discovery that showed how structures such as the early forms of galaxies began to form in the universe
- COBE finished its missions in 1993

Hubble Space Telescope

- Launched in 1990
- A basic reflector telescope with a 2.4 meter mirror
- Orbited 375 miles above Earth
- Views visible, infrared, and ultraviolet light
- Hubble's launch was delayed because of the Challenger explosion

Hubble's Problems

- The curve of Hubble's mirror was wrong
 - It was just a tiny bit too flat-off by a depth about 50 times smaller than the thickness of a human hair
 - The pictures being beamed back to Earth were blurry
- Astronauts went to Hubble and installed a series of coin-sized mirrors in front of the original instruments
 - The new mirrors corrected the effects of the flawed shape of the primary mirror and fixed the blurriness
 - It was as though a pair of glasses had been placed on the telescope

Hubble's Discoveries

- Helped determine the age of the universe and the way galaxies form
- Revealed extraordinary details about the process by which Sun-like stars end their lives as planetary nebulae



Compton Gamma Ray Observatory

- Gamma rays come from some of the most mysterious and powerful objects in the universe: black holes, quasars, supernovae, and neutron stars
- CGRO was launched in 1991
- Orbited 280 miles above Earth
- Instead of collecting light, it tracked rare, difficult-to-detect gamma radiation
- Its four instruments observed gamma rays indirectly by monitoring the flashes of visible light, called scintillations, that occurred when the gamma rays struck the liquid crystal detectors built into the instruments
- Supposed to last for 2 to 5 years, but it lasted until the year 2000
 - NASA decided to bring it out of orbit while it could still direct the satellite's dive into the atmosphere over an unpopulated area
 - The telescope broke apart and burned up above the Pacific Ocean in 2000

CGRO Discoveries

- Established that all the mysterious sources of gamma-ray bursts lie outside the Milky Way Galaxy
- Discovered a nearby supernova remnant



Chandra X Ray Observatory

- Launched in 1999
- Has a highly elliptical orbit that ranges from 9942 miles to 82646 miles above Earth
- It has been able to detect X-ray sources 20 times fainter than anything previously picked up by an x-ray telescope
- X-rays have so much energy that they penetrate a mirror when hitting it
- Chandra's four pairs of mirrors, must be carefully shaped and aligned so that the inner, reflecting surfaces are almost parallel to the incoming X-rays

Chandra's Discoveries

- Has allowed astronomers to study energetic events such as black holes, supernovae, and colliding galaxies
- Found new stars that may have planet-forming disks around them



Spitzer Space Telescope

- Launched in 2003
- Follows the Earth's orbit around the Sun, which helps to keep the telescope cold
- Studies infrared light
- Spitzer has a liquid helium tank that helps keep the parts of the science instruments as cold as 1.4 Kelvin
 - 0 Kelvin, or “absolute zero,” is the lowest temperature possible, at which all motion stops

Spitzer's Discoveries

- Has seen through dust clouds in our galaxy to better allow the study of star formation and black holes

