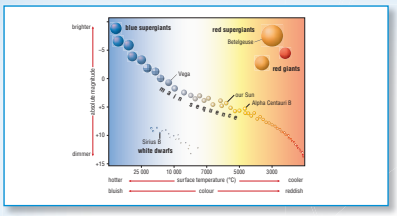
CHAPTER 9

LOOKING BACK

KEY CONCEPTS SUMMARY

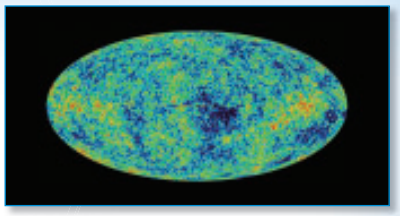


Stars differ in colour, size, and temperature.

- The colour of a star gives astronomers a clue to its surface temperature. (9.2)
- The relationship between the absolute magnitude and temperature of stars can be seen on the Hertzsprung–Russell (H–R) diagram. (9.2, 9.4)
- Stars can be millions of times bigger in volume than our Sun or hundreds of times smaller. (9.4)

Stars change their physical properties over time.

- Stars begin to shine when nuclear fusion occurs. (9.4)
- Stars spend most of their life as "main sequence" stars, as represented on an H–R diagram. (9.4)
- Depending on its mass, a star can end up as a white dwarf, a black hole, or a neutron star. (9.4)

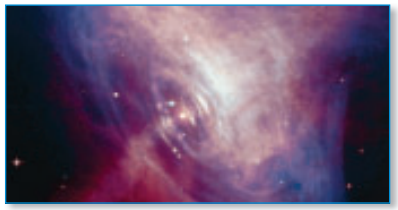


There is strong evidence that the Universe had its origin around 13.7 billion years ago.

- Radiation from the Big Bang can still be detected in the Universe. (9.7)
- Distant galaxies are moving away from us, which is evidence that the Universe is expanding. (9.7)

Stars are clustered into galaxies, which we can observe using telescopes.

- Galaxies are immense and can be made up of hundreds of billions of stars. (9.6)
- Distances to stars and galaxies are measured in light years. (9.1)
- Galaxies can be classified based on their shape as spiral, elliptical, lenticular, or irregular. (9.6)
- Quasars are mysterious galaxies that emit large amounts of energy. (9.6)



Black holes, neutron stars, and supernovas are part of the life cycle of massive stars.

- Black holes are celestial objects that have so much gravity that even light cannot escape. (9.4)
- Pulsars are spinning neutron stars that emit light that sweeps across Earth at regular intervals. (9.4)

Evidence collected by satellites and Earth-based observations support theories of the origin, evolution, and large-scale structure of the Universe.

- The Hubble Space Telescope has taken remarkable pictures of objects near the edge of the observable Universe. (9.4)
- The Cosmic Background Explorer (COBE) and the Wilkinson Microwave Anisotropy Probe (WMAP) created maps of the distribution of radiation in the Universe from the Big Bang expansion. (9.7)

WHAT DO YOU THINK NOW?

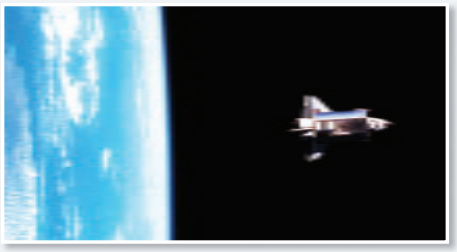
You thought about the following statements at the beginning of the chapter. You may have encountered these ideas in school, at home, or in the world around you. Consider them again and decide whether you agree or disagree with each one.

1 Stars differ only in their size and how far they are from Earth.
Agree/disagree?

4 Scientists can detect everything that there is in the Universe.
Agree/disagree?

2 The Big Bang theory explains how the Universe began.
Agree/disagree?

5 All galaxies in the Universe are like the Milky Way.
Agree/disagree?



3 Spacecraft orbiting Earth can observe objects that are billions of kilometres away.
Agree/disagree?

6 Telescopes allow astronomers to see all of the celestial objects in the Universe.
Agree/disagree?

How have your answers changed since then? What new understanding do you have?

Vocabulary

light year (p. 365)
parallax (p. 367)
luminosity (p. 370)
apparent magnitude (p. 371)
absolute magnitude (p. 371)
solar mass (p. 373)
nebula (p. 375)
protostar (p. 375)
main sequence (p. 377)
red giant (p. 377)
red supergiant (p. 378)
white dwarf (p. 378)
supernova (p. 379)
neutron star (p. 380)
black hole (p. 380)
star cluster (p. 385)
elliptical galaxy (p. 386)
spiral galaxy (p. 386)
lenticular galaxy (p. 386)
irregular galaxy (p. 386)
quasar (p. 389)
red shift (p. 394)
Big Bang theory (p. 395)

BIG Ideas

- **Different types of celestial objects in the Solar System and Universe have distinct properties that can be investigated and quantified.**
- **People use observational evidence of the properties of the Solar System and the Universe to develop theories to explain their formation and evolution.**
- **Space exploration has generated valuable knowledge but at enormous cost.**