CONCEPT 2

The big bang theory helps us describe how the components of the universe formed and have changed over time.

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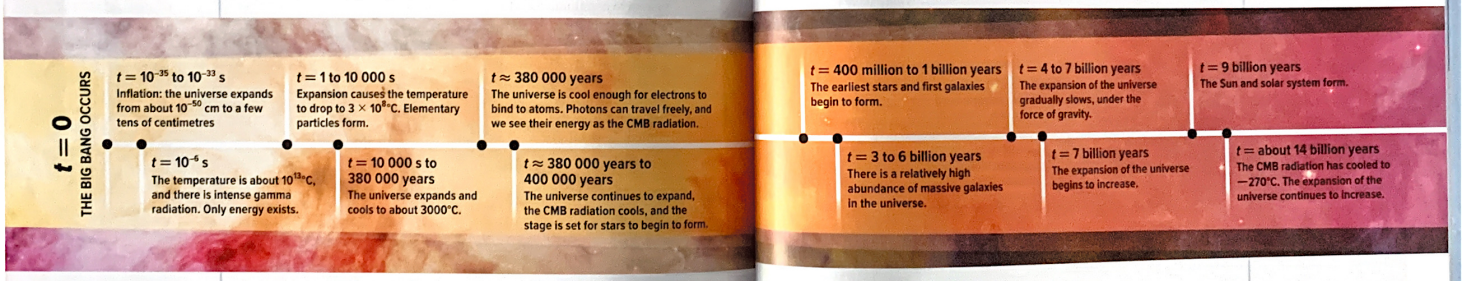
Modern telescopes can see enormous distances into the universe, which means that they can see very far back into the past. The reason for this is the finite speed of light. For example, light from the Sun takes about 8 min to reach Earth. So, we always see the Sun as it was 8 min ago. The nearest stars are about 4 light-years away. Thus, their light takes 4 years to reach us. We see these stars as they were 4 years ago. Looking at galaxies that are 10 billion light-years away gives us a view of the universe as it was 10 billion years ago.

A Young Universe

The COBE and WMAP images are pictures of the CMB radiation (now cooled to about −270°C) when the universe was a mere 380 000 years old (about 0.002 percent of its present age). At that time, the universe was smaller. Yet, from our point of view in space and time, the tiny universe (in the past) appears to be a huge distant shell that surrounds us. We see it in all directions, at a very great (redshifted) distance when it was, in fact, smaller.

Figure 4.43 Timeline from the big bang to the present. **Questioning: What questions do you have as you read and reflect on the information in this timeline?**



Evolution of the Universe

Astronomers have collected enough observations from different types of telescopes to piece together a fairly detailed picture of how the universe has evolved since the big bang. Of course, the details are always being refined because new discoveries are made with surprising regularity. Figure 4.43 presents a timeline of the evolution of the universe from the big bang until the present.

The James Webb Space Telescope

At the time this is being written, the Hubble Space Telescope (HST) is still in use, having had its scheduled retirement delayed several times. In 2020, NASA plans to launch its replacement: the James Webb Space Telescope (JWST). The JWST will see even farther than the HST can. Its mission will be to find the first galaxies that formed after the big bang. The Canadian Space Agency is a partner in the development of the JSWT.

CERN

In September 2008, an organization called CERN (Conseil Européen pour la Recherche Nucléaire), in Switzerland, began the full-scale operation of the world's most powerful machine for studying particles at high energies. This machine, called the Large Hadron Collider (LHC), can conduct experiments at energies that approach those found in the universe 10^{-12} s after the big bang. Scientists hope to unravel some of the secrets of the very early universe by studying what happens at these incredibly high energies.

Designing and building machines such as the LHC takes a great deal of creativity. Sometimes, new technologies have to be invented to make the machines and to enable scientists to share the information they learn. The technologies can then be modified and used by the public. For example, scientist Tim Berners-Lee invented the World Wide Web at CERN, in 1989, so that all the scientists could share the information on their computers.

Before you leave this page . . .

1. Use a flowchart to summarize the key events of the big bang.
2. Explain how technology has helped us understand the origins of the universe.