explore much more than just the objects in our universe and the latest discoveries about them. We will pay equal attention to the *process* by which we have come to understand the realms beyond Earth and the tools we use to increase that understanding.

We gather information about the cosmos from the messages the universe sends our way. Because the stars are the fundamental building blocks of the universe, decoding the message of starlight has been a central challenge and triumph of modern astronomy. By the time you have finished reading this text, you will know a bit about how to read that message and how to understand what it is telling us.

1.1 The Nature of Astronomy

Astronomy is defined as the study of the objects that lie beyond our planet Earth and the processes by which these objects interact with one another. We will see, though, that it is much more. It is also humanity's attempt to organize what we learn into a clear history of the universe, from the instant of its birth in the Big Bang to the present moment. Throughout this book, we emphasize that science is a *progress report*—one that changes constantly as new techniques and instruments allow us to probe the universe more deeply.

In considering the history of the universe, we will see again and again that the cosmos *evolves*; it changes in profound ways over long periods of time. For example, the universe made the carbon, the calcium, and the oxygen necessary to construct something as interesting and complicated as you. Today, many billions of years later, the universe has evolved into a more hospitable place for life. Tracing the evolutionary processes that continue to shape the universe is one of the most important (and satisfying) parts of modern astronomy.

1.2 The Nature of Science

The ultimate judge in science is always what nature itself reveals based on observations, experiments, models, and testing. Science is not merely a body of knowledge, but a *method* by which we attempt to understand nature and how it behaves. This method begins with many observations over a period of time. From the trends found through observations, scientists can *model* the particular phenomena we want to understand. Such models are always approximations of nature, subject to further testing.

As a concrete astronomical example, ancient astronomers constructed a model (partly from observations and partly from philosophical beliefs) that Earth was the center of the universe and everything moved around it in circular orbits. At first, our available observations of the Sun, Moon, and planets did fit this model; however, after further observations, the model had to be updated by adding circle after circle to represent the movements of the planets around Earth at the center. As the centuries passed and improved instruments were developed for keeping track of objects in the sky, the old model (even with a huge number of circles) could no longer explain all the observed facts. As we will see in the chapter on Observing the Sky: The Birth of Astronomy, a new model, with the Sun at the center, fit the experimental evidence better. After a period of philosophical struggle, it became accepted as our view of the universe.

When they are first proposed, new models or ideas are sometimes called *hypotheses*. You may think there can be no new hypotheses in a science such as astronomy—that everything important has already been learned. Nothing could be further from the truth. Throughout this textbook you will find discussions of recent, and occasionally still controversial, hypotheses in astronomy. For example, the significance that the huge chunks of rock and ice that hit Earth have for life on Earth itself is still debated. And while the evidence is strong that vast quantities of invisible "dark energy" make up the bulk of the universe, scientists have no convincing explanation for what the dark energy actually is. Resolving these issues will require difficult observations done at the forefront of our technology, and all such hypotheses need further testing before we incorporate them fully into our standard astronomical models.

This last point is crucial: a hypothesis must be a proposed explanation that can be *tested*. The most straightforward approach to such testing in science is to perform an experiment. If the experiment is