**Science in General**

Scientific knowledge is based on observations of nature. From observations of many different events and situations, scientists try to find patterns and create generalizations as to the underlying fundamental processes involved. Then they experiment again to see if the right guess was made of what the rule is that nature follows under a given situation. *Experiments determine scientific truth.* The scientist usually learns about nature by using controlled experiments in which only one thing at a time is varied to determine whether or not a particular situation, feature, or circumstance can be determined to be the *cause* of an observed effect. The experiments can be repeated by anyone as many times as they want to verify that the effect is reproducible. The astronomer cannot do controlled experiments. They cannot even examine things from a variety of angles. What astronomers do is collect light and other radiation from celestial objects and use all of their information and creativity to interpret the signals from afar. They look for the experiments nature has set up for us and hone on a few basic characteristics at a time.

**Scientific Models**

Scientists will create **models** (simplified views of reality) to help them focus on the basic fundamental processes. In this context a **model** is an abstract construct or idea that is a simplified view of reality, not something made out of paper, wood, or plastic (or some good-looking person). Scientific models must make testable predictions. Like any scientist, the astronomer makes observations, which suggest hypotheses. These speculations are made into predictions of what may be observed under slightly different observing and/or analysis circumstances. The astronomer returns to the telescope to see if the predictions pan out or if some revision needs to be made in the theory. Theory and observation play off each other.

Often the evidence for a particular hypothesis is indirect and will actually support other hypotheses as well. The goal is to make an observation that conclusively disproves one or more of the competing theories. Currently unresolvable questions may be resolved later with improved observations using more sophisticated/accurate equipment. Sometimes new equipment shows that previously accepted theories/hypotheses are wrong!

*Scientific models and theories must make testable predictions.* If an explanation is offered that has no concrete test that could disprove the explanation in principle, it is not a scientific one. This characteristic of scientific explanations is often the distinguishing one between scientific and other types of theories or beliefs (religious, astrological, conventional wisdom, etc.). Do understand that a scientific theory can be *incorrect* but still be considered a *good* scientific theory because it makes a testable prediction of what will happen under a given set of observing or analysis circumstances.

**A Definition of Scientific Truth**

Explanations and theories that correctly predict new results from new observations or experiments bring us closer to a true understanding of nature and the rules by which it operates. This true understanding of nature is what I call ``scientific truth'' in this text to distinguish it from other definitions of truth as in religious truth, for example. Scientific truths are based on clear observations of physical reality and can be tested through observation. Certain religious truths are held to be true no matter what. That is okay as long as it is not considered to be a *scientific* truth. Some things like love, honor, honesty, and compassion are known to be right or true without the test of experiments. Confusion between the religious and scientific types of explanation has been, and still continues to be, the source of a huge amount of conflict between many people. Yes, it is possible to be a scientist and a devout member of a spiritual faith---I know of many scientists who are serious practitioners of their religion. In fact, several significant advancements in science were made by clergy. In the [astronomy history chapter](http://www.astronomynotes.com/history/s1.htm) you will find several examples of scientists who were guided by their spiritual faith. Not all scientists are believers in a spiritual faith just as not all non-scientists are believers in a spiritual faith.

Since this is a science textbook, I will focus on the scientific type of explanations. Whether or not you, the reader, chooses to *believe* what is discussed here is up to you. However, I want you to *understand* the physical principles discussed here and be able to apply them to various situations. The scientific method for finding scientific truth is discussed in more depth in the [scientific method chapte](http://www.astronomynotes.com/scimethd/s1.htm)