*Assignment - Highlight the important terms. For each paragraph, write one sentence summarizing the most important point.*

# **The History of Astronomy as an Example of Scientific Methodology**

Science can be defined as a method of learning about the world and universe around us. Any area of study following scientific methodology then qualifies as science. Scientific methodology uses experimental and observational data to test hypotheses, models or theories. To qualify as scientific, these hypotheses, models, or theories must be subject to being proven wrong by the data. They must be falsifiable. When data and theoretical models disagree, scientists should always modify the theoretical models to make them agree with the data.

## **Astronomy as an Example**

The historical development of astronomy provides a good example of this scientific process.

Since the dawn of humanity, people have observed the night sky. Ancient cultures observed various motions in the sky including the relative motions of the planets against the stellar backdrop.

To scientifically explain these observed motions, ancient Greeks, culminating with Ptolemy, developed the first scientific models. Ptolemy’s model was geocentric. It placed Earth at the center of the cosmos. Greek aesthetic ideas favored circles and spheres as perfect geometric figures. The ancient Greeks thought that celestial objects must be perfect spheres moving in circular paths at a uniform speed. All celestial objects therefore moved around Earth in paths consisting of combinations of uniform circular motions.

To develop the final Greek model, Ptolemy modified details of previous versions so that the predicted positions of planets and other celestial objects would agree with observed positions. The Ptolemaic model was therefore good science because it changed the model to conform to the data. The model’s predictions agreed with the observations of planetary positions to within the accuracy of the observations available at the time. The fact that it later turned out to be incorrect does not make Ptolemy’s model bad science.

In the 16th century, Copernicus proposed an alternative heliocentric model that placed the Sun at the center of the solar system. Copernicus however continued with the Greek tradition of uniform circular motion. In Copernicus’s model the planets orbited in circular orbits around the Sun, so the Copernican model was no more accurate than the Ptolemaic model in predicting positions of planets. Copernicus was motivated by aesthetics, or intellectual beauty, rather than data. The importance of aesthetics in science is often underappreciated.

To decide which competing model was better, astronomers needed more accurate data. Tycho Brahe supplied these data. Tycho spent his entire career collecting data on positions of celestial objects with an unprecedented accuracy.

When Tycho died, Johannes Kepler used Tycho’s data to modify the Copernican heliocentric model. Most notably, Kepler’s model used elliptical orbits rather than the traditional circular orbits. Why? Tycho’s data demanded the modification. Kepler was unable to find a combination of circular orbits that agreed with Tycho’s accurate data, so he modified the model to use elliptical orbits. Elliptical, but not circular, orbits agreed with Tycho’s more accurate data.

Kepler also devised his three laws of planetary motion. Newton later devised the laws of motion that explained Kepler’s laws. In the early 20th century, Einstein’s special and general theories of relativity modified Newton’s laws for certain situations in which Newtonian predictions did not agree with data.

Notice that the various steps in [scientific methodology](http://www.decodedscience.org/what-is-science/2833) are incorporated into the development of astronomy. Specifically better data falsified the models, compelling astronomers to modify and improve their understanding of the cosmos. Also notice that these steps were not all performed by a single scientist. Rather the scientific process often occurs over millennia.

This scientific process defines science. Furthermore, the history of astronomy provides a good case study of how scientific methodology really works.

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