Lesson Plan: Theories

Overview

This activity will help the students understand that science theories change in the face of new evidence, but those changes can be slow in coming. Before Galileo, most of the world's educated people believed that the rest of the universe moved around the Earth: a geocentric model. Contrary to popular opinion today, their view was not the result of a failure to make careful observations. The earth-centered model—although now known to be incorrect—was actually very well understood by natural philosophers, who were able to use it to make accurate predictions about the movement of heavenly bodies.

We hope that your students come away from this activity with an appreciation for the sophistication of the geocentric model, which is most commonly associated with Ptolemy. You may wish to explain that at the point when natural philosophers abandoned the geocentric model, it was actually a better predictor of astronomical events than was the heliocentric (sun-centered) model of our solar system. However, the scientific community of the day appreciated the relative simplicity of the heliocentric model that was developed by Copernicus and Galileo, and anticipated that once refined, it would prove to be better able to predict future events.

The same process happens today. When new explanatory frameworks—or "theories"—are proposed to explain scientific phenomena, there is often a lengthy period during which groups of scientists use different competing theories to explain the same phenomena. Cosmic gamma ray bursts were first identified in the 1960s, but in the mid-1990s, there was still active debate among the astronomers about their source. Some astronomers believed that they originated just outside our galaxy; others argued that they occurred much farther away. We now know the latter theory is correct.

Objectives

Students will

- Observe how scientific theories can change over time
- Be introduced to the sophistication of the geocentric model and the time it took to change the theory underpinning the heliocentric model
- Compare the heliocentric model to the geocentric model

Assessment Strategies

Questioning students to see their understanding of how retrograde motion is justified in both models and how theories can persist over time. See Teachers Notes PDF Document for elaboration.

Grade Level: 5-8

Suggested Time

30 minutes

Multimedia Resources

- Astronomy Theories QuickTime Video

Materials

- One or more computers with QuickTime installed (available free at http://www.apple.com/quicktime/download/)
- QuickTime movies available from our website (http://csats.psu.edu/files/SWIFT): Geocentric_1.mov, Geocentric_2.mov. Alexandria_Mars.mov, Alexandria_Mars_Path.mov. Students can view these on their own computers, but it will probably be better to project them to the entire class.
- Computers with internet access
- Student Handout PDF Document: The Voyage of Mars in the Ancient Night Sky
- Figures 1-3 (see Teachers Notes PDF Document)

Procedures

See Teachers Notes PDF Document for elaboration.

Part 1: Show your students Video 2:

Astronomy Theories QuickTime Video

[Time – 4:58]. Explain how theories compete and are developed by different theorists through investigation over a long period of time. Refer to the theories of gamma-ray bursts (GRBs) or, Aristotle and Ptolemy's model of the universe as examples.

Part 2: Guide students to understanding why the geocentric model persisted for so long

- Show and explain your students the QuickTime clip, Alexandria_Mars.mov
- Discuss the movement of Mars in the movie. Next, allow students to work on The Voyage of Mars in the Ancient Night Sky (see Student Handout) in groups.
- Briefly explain the terms "Azimuth" and "Altitude." Figure 1 may make this easier. (See Teachers Notes PDF Document, pg. 7)
- Discuss your students' findings, before showing the second QuickTime clip, Alexandria_Mars_Path.mov which might help students understand what their own maps show.
- Show and explain the third QuickTime clip, Geocentric_1.mov
- Show the fourth QuickTime clip, Geocentric_2.mov and explain Ptolemy's solution to the problem of retrograde motion, illustrated on Figure 2 (see Teachers Notes PDF Document, pg.

8).

- As a final point, conclude that the geocentric theory was well received and lasted for more than a century.

Part 3: Ask the students if they know how Mars exhibits retrograde motion in the corrected model (heliocentric model). Explain why retrograde motion occurs according to the heliocentric model, by using Figure 3 (see Teachers Notes PDF Document, pg. 9). Then discuss both models with students.