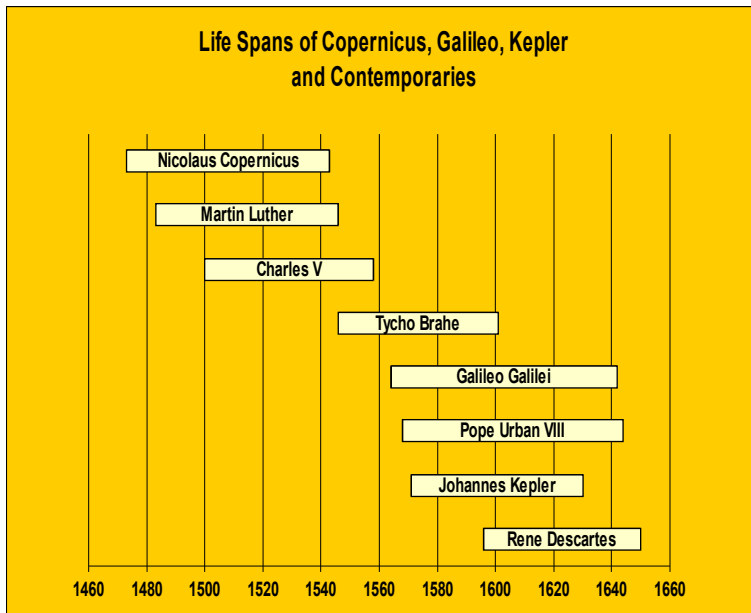


Copernicus, Galileo, and Kepler in Context



Astronomy has always been about observation and measurement, and early civilizations devoted great effort to trying to understand the daily, monthly, yearly and longer cycles that could be observed with the naked eye. A calendar that could accurately predict these repetitive cycles was an invaluable aid to societies that needed to make critical decisions about when to plant and when to harvest, when to prepare for floods and when to seek shelter from approaching winter, when to hunt and when to stockpile food.

Every civilization developed ways to meet this challenge and also developed elaborate stories and belief systems to explain how the visible, observable universe worked, with

most assuming that the earth was the immovable center. With such limited observational data available, alternative theories of the universe could easily co-exist, as long as each could provide a plausible and internally consistent explanation of observable heavenly phenomena. Astronomy belonged more to the realms of philosophy and religion than to what we would call science.

With hindsight, of course, it is easy to see that some theories came much closer to our modern understanding than others. Although never dominant because it seemed to contradict everyday sensory perceptions, early heliocentric theories appeared in ancient Greece, India, and Persia. The roundness of the Earth, its axial tilt, and its approximate size were also estimated with surprising accuracy, while solar and lunar eclipses and planetary motions were predicted with elaborate models. But these remarkable insights never really advanced man's understanding of his place in the universe, because they could not be verified through any evidence available to the naked eye. Philosophical authority and religious conviction usually carried more weight than scientific hypotheses.

It's hard to put ourselves back to the moment when all that changed, when suddenly, 400 years ago, the new technology of the telescope transcended the observational limits of past millennia and put mankind on a path of ever-increasing observational power and precision that continues to this day. Over the last four centuries, many of the questions that once seemed unanswerable have been laid to rest, only to be replaced with equally challenging questions about the origin, size, and composition of the universe. As our knowledge grows, our physical place in that universe shrinks to insignificance as we continue the process of redefinition begun by Copernicus, Galileo and Kepler.

In looking back, it is also hard for many of us to understand why it should have taken more than 150 years for the heliocentric theories of Copernicus, the careful observations of Galileo, and the ingenious calculations of Kepler to gain widespread acceptance. Beliefs die hard, and beliefs that are central to man's self-image and to his understanding of his perceived role in the universe are especially resistant to challenge. Lest we get too smug when judging the intellectual struggles of the past, it is good to remind ourselves that Darwin's theory of evolution was published 150 years ago and has been reinforced by a steady stream of scientific evidence since then. Nevertheless, a majority of people in the United States still do not accept the validity of evolution, and major elements of the world's great religions continue to resist incorporating evolutionary science into their belief systems.