Cosmic Chemistry: Cosmogony

Cosmogony or Cosmology?

TEACHER TEXT

BACKGROUND INFORMATION

The designers of this *Cosmic Chemistry* module struggled with its title. Should it be named Cosmogony or Cosmology? Cosmology is the study of the structure and changes in the present universe, while the scientific field of cosmogony is concerned with the origin of the universe. Observations about our present universe may not only allow predictions to be made about the future, but they also provide clues to events that happened long ago when the chemical evolution of the cosmos began. So--the work of cosmologists and cosmogonists overlaps.

Genesis, the name of the NASA mission for which this module was created, means "the beginning," so this module could appropriately be entitled Cosmogony. Library searches under this keyword, however, came up relatively empty. Most, if not all, the resources listed at the end of the module, were found under the topic of "Cosmology." This may be because the materials in most of these references are based on past and present scientific findings of the cosmic structure. At the same time, most of them also included some reference to the theories of the cosmic beginnings.

Therefore, it was decided to maintain the title of Cosmogony for the module, while at the same time, using the terminology presently found in common use in references—cosmology and cosmologists—in the textual material. Students are introduced to definitions of these terms in the Student Text, "Tracing Origins."

Perhaps even more than in the other cosmic chemistry modules, the students' attention is focused on models, especially mathematical models, since many features of the universe are minimally observable or only presumed to exist based on indirect evidence. Cosmology is pursued like most of today's scientific research: develop a hypothesis or model, perform experiments, and produce data that can be validated or challenged by other experimentalists. However, cosmology suffers in comparison to other sciences in the sense that more models exist than do experimental facts, since the latter are so difficult to obtain when one deals with the universe as a whole. Consequently, cosmology is very much a speculative science requiring assumptions, inferences, and enormous extrapolations in time and space. These topics are more fully dealt with in Appendix B, "Assumptions, Models, and the Scientific Method."

Among the various areas of scientific endeavor, cosmology is unique in that the experiments designed to validate cosmological thinking are the largest conceivable because everything created falls within the domain of the cosmologist. In other ways, it is conventional, because the laws and theories of long-established mathematics and physics provide the operational framework. For example, the laws of thermodynamics, largely developed in the 19th century, reign supreme in cosmology. Thus, we see that cosmology, like other branches of science, owes its development to a series of minds, each with its own strengths, providing insights built on the advances of a predecessor. The lineage is indeed impressive-Aristotle, Ptolemy, Copernicus, Brahe, Kepler, Newton, Faraday, Maxwell, and Einstein. As Newton said, "If I have seen further than others, it is because I have stood on the shoulders of giants." Appendix A, "Cosmology," reviews the history of the science and Appendix C, "Selected Noteworthy Events in Cosmology," provides a "history at a glance" overview of dates and scientific advances relating to the activities in this module.

During the Exploration activities of the Cosmogony module, students will develop an understanding of the difficulties of conducting science on the scale of the universe and of the necessity to escape from our earthbound frame of reference. Through classroom activities they will examine some aspects of the contemporary models of the origin of the universe. Other activities will encourage students to delve into the concepts of time and space and of working backward from a known final state to a plausible initial state.

There are a number of esoteric, highly mathematical, and conceptually difficult concepts in cosmology that challenge even advanced physics students. The concepts of space-time, space curvature, grand unification, and non-Euclidean geometry are good examples. Owing to the complexity of these topics, they are not presented as activities; however, brief discussions of some of them are presented at appropriate points in the module.