Science Modules

This module focuses on the origin and evolution of the universe. If you are using Genesis science modules for the first time, read the User's Guide thoroughly before you begin. (*View User's Guide as PDF.*)

The following classroom materials are available in Portable Document Format (PDF) for your browsing and printing convenience. The files are print-optimized, and should be printed to achieve maximum resolution. **Adobe's new Acrobat Reader 4.0 is required** to view and/or print. To install the FREE reader, visit the Adobe Web site.

Take a look at additional science modules that are available on the Genesis Web site. All technical terms in the science modules are compiled in the Glossary for easy access.

Technology Applications are available for this module.

Cosmic Chemistry: Cosmogony

Cosmologists study the present universe, while cosmogonists study the origin of the universe. Observations about our present universe not only allow predictions of the future, but they also provide clues to events that happened long ago when the chemical evolution of the cosmos began. Throughout this module, students study models, especially mathematical models, since many features of the universe are minimally observable or only presumed to exist based on indirect evidence. They develop an understanding of the difficulties of conducting science on the scale of the universe and of the need to escape from our earthbound frame of reference. Classroom activities examine some aspects of the contemporary models of the origin of the universe, the concepts of time and distance, and the strategy of working backward from a known final state to a reasonable initial state.

Instructional materials for this phase are incorporated into Exploration activities below.

Module Planning Guide

Cosmogony or Cosmology?
- Teacher Text

Briefing

The primary objective of the Genesis mission is to collect samples of solar wind particles and return them to the Earth for detailed analysis. Precise analysis of these particles will provide solar isotopic and elemental abundances, and thus will form a basis for testing models of solar system formation, evolution, and early nebular composition.

These solar system models ultimately must fit in with models of the formation of the universe, as tiny parts of the whole, but ones for which comparatively complete data exists. The information obtained from the Genesis mission pertaining to the primordial solar system should ultimately prove useful to cosmologists and cosmogonists, since the solar system is thought to have originated from a disk-shaped cloud of gas and dust when the universe was about two-thirds its current age. Thus, the Genesis mission becomes a part of the necessary cosmological strategy of working backwards through time toward a beginning.

Mathematical Models
- Teacher Guide
- Student Activity
- Anticipation Guide
- Appendix A
- Appendix B

Density and Gravity—The Push and Pull of the Universe
- Teacher Guide
- Student Activity
- Student Data/ Reporting Sheet
- Anticipation Guide
- Student Text

Doppler Effect—Are You Coming or Going?
- Teacher Guide
- Student Data/ Reporting Sheet
- Student Handout
- Student Activity
- Student Text

Quarks—Getting Down to Fundamentals
- Teacher Guide
- Teacher Tools
- Student Activity, Part I
- Student Activity, Part II
- Student Activity, Part III
- Student Text

Thought Experiments: Tracing Origins
- Student Text
- Student Handout

Exploration

In the activities of this module, the teacher's primary role is Socratic. Through effective questioning, students should become aware of the relationship between what scientists observe and the theories and models that they develop from the observations.

The Student Activity, "Mathematical Models," emphasizes the fact that cosmology is, of necessity, a mathematical science, and it illustrates the power of mathematics to organize our thoughts and to direct the course of future investigations. During this activity, students should be guided to an understanding of the various kinds of models used by scientists and how observations are converted into useful logic-based models.

The Student Activity, "Density and Gravity—The Push and the Pull of the Universe," focuses on the importance of a very simple concept (gravity) to cosmological thought while stressing the difficulty of determining the density of something as vast and poorly defined as the universe. The part of this activity dealing with gravity is designed to underline the crucial role that this extremely weak force plays in determining the structure of the universe.

The Student Activity, "Doppler Effect—Are You Coming or Going?" illustrates the application of a simple technique that has been a mainstay of cosmological science since the early part of the 20th century. After students develop a physical model that simulates the Doppler effect, they proceed to explore some actual cosmic Doppler data and draw conclusions based on these observations.

The Student Activity, "Quarks—Getting Down to Fundamentals," focuses the students' attention on extrapolations into the unknown by inference. The inferred information is used to build models consistent with observable contemporary data about fundamental particles and how this matter relates to the origin of the universe.

Curriculum Connections

National Standards Addressed

Grades 9-12

Science as Inquiry
- Understandings about scientific inquiry
- Abilities necessary to do scientific inquiry

Physical Science
- Structure of atoms
- Motions and Forces
- Structure and properties of matter
- Interactions of Energy and Matter

Earth and Space Science
- The Origin and Evolution of the Earth System
- The Origin and Evolution of the Universe

Science and Technology
- Understandings about Science and Technology

History and Nature of Science
- Science as a Human Endeavor
- Nature of Scientific Knowledge
- Historical Perspectives

Student Mission

Students will explore the inferences that can be made from the limited set of cosmological data available, including that from deep space, to gain an appreciation for the enormous difficulties faced by cosmologists as they attempt to define and describe our universe. They will develop an awareness of some of the "missing pieces" in the overall picture.

A Spongy Universe
- Teacher Guide
- Student Activity
- Student Text

Dark Matter—More Than Meets the Eye
- Teacher Guide
- Student Activity
- Student Text
- Appendix C

PowerPoint Presentation
- Teacher Guide for PowerPoint
- Teacher Notes for PowerPoint

Development

Use the Student Activities, “A Spongy Universe” and “Dark Matter—More Than Meets the Eye” to create interest in learning more about the structure of the universe and the models that are now being considered. The "Spongy Universe" activity emphasizes two things. The first is that how we view things often depends on our perspective, and the second is how our view of the universe from here in the solar system is very limited by our perspective. The “Dark Matter” activity encourages students to wrestle with the difficulties faced by scientists when they do not have information on which to base models. The activity also focuses on the intellectual developments that are necessary in order to address these obstacles.

Instructional materials for this phase are incorporated into the Exploration and Development activities above.

Interaction/Synthesis

Student interactions with peers are emphasized as the class pursues the tasks set forth in the exploration and development activities above. The activities contain work to be done in groups, with the whole class participating in preliminary and summary discussions.

Cosmic Tug of War
- Teacher Guide
- Student Activity
- Student Text

Assessment

In the assessment activity, “Cosmic Tug of War,” students are asked to decide which of two cosmic forces (expansion and gravity) will dominate the future of the universe. In addition to their background from the Exploration and Development activities of the module, they will use the more quantitative information in the student text for the Assessment activity and the references for the module to make and defend their decisions. Students may also be required to make physical models of the future universe.

Curriculum Connections

National Standards Addressed

Assessment Standard B
- Achievement and Opportunity to Learn Science must be Assessed

Assessment Standard C
- Assessment Tasks Are Authentic

TEACHER RESOURCES

View a listing of additional resources that includes URLs, books, and periodicals.

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