Mathematics at the Frontier of Astronomy

Guide for Curriculum Unit 07.03.08
by Hermine Smikle

Early astronomers investigated the phenomena in the heavens through observations. The data collected from these observations were carefully documented. The application of mathematics and physics helped in the explanation and understanding of those observations. Physics helped to explain and interpret the physical phenomena, while mathematics attempts to provide a quantitative model for the events.

The subject of astronomy, if taught at the middle and high school levels, is concerned mostly with the physical features of the solar system, the planets, and their orbits. The mathematics involved is usually not taught because it is considered to be too difficult for the students at those levels. This curriculum unit is written with the purpose to present some of the concepts of mathematics that are applied to selected topics in astronomy.

The Main Focus of the Curriculum Unit

Section 1: This section is written to stimulate students' interest in the topic and provide the historical setting for the development of the study of astronomy. In this section the contribution of early Greek and Arab observers is discussed. Contributions of early astronomers Copernicus, Brahe, Kepler, Galileo, and Newton are discussed. This historical time line is designed to give students a look back at how these discoveries and inventions of the earliest astronomers have laid the foundation of present day astronomy.

Section II: An attempt is made to make some connection to mathematics. The topics discussed include escape velocity, gravity, orbital motion, cosmic distances and stellar parallax. These concepts are not usually included in regular school curricula. These are chosen to given students the opportunity to discuss these mathematical concepts since these are usually heard in the context of space programs.

Section III: The focus of this section is to use the mathematical models to solve problems. Efforts are made to present topics to occupy students in an AP calculus course after they have completed the AP examinations. The challenge is to find challenging but interesting topics that can be used to compliment the regular curriculum. The goal therefore, is to use this unit to engage students. The unit will minimize teacher talk, but will have students working together or individually to do research, make presentations, and solve problems. The concepts in most cases will be introduced with a significant task. This will require students to do some investigation on their own. To facilitate discussion of concepts in the unit, students will be asked to visit the NASA Web site and view the information. Selected Web sites will be visited in class to present the concept.

(Developed for AP Calculus, grade 12; recommended for Mathematics and Science, grades 11-12)