

TEACHING SCIENCE THROUGH OBSERVING VARIABLE STARS

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Abstract

In this paper we report on the study of variable stars as part of a program at the University of North Texas to encourage students to participate more in the sciences and mathematics. Most introductory science courses do not give students a lasting feeling for science, so this program is being developed to introduce students to the techniques of science by allowing them to play active roles in variable star research.

1. Introduction

Society today is technologically dependent, science having revolutionized modern lifestyles in a single generation (Perutz 1989). If the trend in scientific and technological advancements continues, future society will be even more heavily dependent upon science and technology, necessitating an even more scientifically literate public than now exists (Patel 1994).

Public policy issues today require a scientifically literate public to make informed decisions (Perutz 1989). Scientific literacy demands the ability to cope adequately with the various components of public policy which involve science (Hazen and Trefil 1991). A scientifically literate public should be regarded as essential to furthering society as a whole (Sawhill 1979), and therefore should be a major component of national policy (Gore 1993).

Observations of light curves for variable stars provide excellent introductory research opportunities for students (Percy 1993; Burke 1993; Gaskell 1991). The skills necessary to make basic observations on variable stars can be learned in a semester. A modest investment in equipment and a dedicated group of observers can make useful contributions to star research (Levy 1989).

The weather can make observing variable stars problematic. It is necessary to be prepared to conduct research at all hours of the night to acquire enough data on the periods of variables to produce useful results. Variables with very short periods are good candidates to study, in that a complete cycle may be observed in a given night, if viewing conditions are favorable. In order to prevent failure in the effort, a dedicated group of researchers is required to keep the effort going continuously.

2. Institutional setting

The University of North Texas is a public university of about 27,000 students located in the northern sector of the Dallas-Fort Worth metroplex. The university operates an observatory approximately 5 miles north of Denton. The university offers baccalaureate, master, and Ph.D. programs in physics. Courses in astronomy are taught by physicists; the department does not offer a degree in astronomy.

The astronomy observatory has seven permanently mounted telescopes and several portable telescopes which range from 6-inch refracting telescopes to 14-inch Schmidt-Cassegrain telescopes. In addition to telescopes, advanced students are allowed to use

an Optec SSP-3 photoelectric photometer with Johnson B and V filters to make measurements. Personal computers for data analysis as well as star charts to aid in locating celestial objects are available at the observatory. Students also have access to computational facilities on the university's main campus.

The Department of Physics provides an outreach program to bring science in general, and specifically astronomy, to the public through a series of open house programs during the year. The university has offered teacher workshops in astronomy and regularly offers a continuing education course in astronomy.

In addition to non-credit activities, the University of North Texas offers a two semester introductory course in astronomy with an accompanying laboratory for each semester. For the past two years a variable star research methods class has been offered.

3. Variable star observations course

Science is best learned through practicing it. It has been suggested that research projects may be a better way to teach science than traditional laboratory courses (Ediger 1994). The variable star observations course at the University of North Texas in a laboratory setting offers students the opportunity to experience science by conducting hands-on exercises.

During the course, the students are introduced to basic concepts of variable stars and astronomy in general. Students are assigned homework activities that acquaint them with library resources. Lectures include the topics of basic stellar models, types of variable stars, data collection, and data analysis. Most of the course is designed to incorporate students into projects related to variable star research. As part of the course, each student is required to write a term paper on a selected variable star and to give an oral report on their project. They are expected to show that they have done a complete literature study and can compare their own results with those of others and make projections of what future studies should be done on the star.

4. Student projects

The students are allowed a wide latitude in developing the star projects. Over the last two years, student projects have evolved from individual projects tracking a single variable star during the semester into a class project of tracking several variable stars. Each member of the class involved in the program conducts their own minor project, which facilitates the overall class project.

Student projects consist of observing variable stars and writing computer programs to reduce photometric readings to magnitudes. Usually, several variable stars are targeted for study. The students work in groups of two or three to collect data for their own star of interest and assist others in the group.

In order to maximize the group training, students with minimal telescope experience are paired with those who have more experience. Furthermore, when the students assist each other in data collection, the observations of a particular star are less affected by such problems as work schedules or conflicts with assignments from other courses.

The following types of variable stars are available for observation:

Mira variables: A major advantage in studies of the Mira variables is that they frequently have large variations in magnitude which are easy for the students to measure. The most serious drawback is that such stars generally have periods longer than one semester duration. Unless students have easy access to archival data, such stars are not the most useful project stars.

UV Ceti stars: Flare stars are exciting to watch if they are flaring, but most students are not excited about watching a star for an entire night to see if it flares.

Cepheid Variables or RV Tauri stars: Both of these types of stars can cycle through

an entire period during the course of one semester and may vary over a range large enough to be easily detectable by beginning students. Skies over the observatory are frequently cloudy, with clear skies only a few days at a time. Reliable measurements may be prevented for up to two or three weeks at a time. Large portions of the light curve are generally missing for a single semester of observing these stars.

Singular Events: A nova or a supernova provides an excellent project for variable star exercises. Students are excited to be measuring an event that is unique. Unfortunately, one cannot count on a nova or supernova in a convenient part of the sky every semester.

Eclipsing Binaries: The most successful studies in the program have been with short period eclipsing binary stars. Such stars generally have minima on many clear nights during the semester. Bright, short period, eclipsing binary stars provide a very good chance that the star will be observed during minimum for several nights each semester.

After each student selects a project star, they do an extensive literature search on the chosen stars. Comparison and check stars are determined for use with differential photometry. Observations of project stars are made, and the photoelectric data are reduced for comparison with published results. For eclipsing binaries, students compare the times of minima with published ephemeris equations, and construct O-C plots.

5. Summary

Students are able to learn what science is about by participating in science projects. This paper reports on a program started at the University of North Texas in 1993 which allows students to experience science activities through the study of variable stars. Each student selects one or more stars to study, conducts a literature search, observes their stars, and reports the results of their observations. The program appears to be effective in that several students have continued their interest in variable star observations after the end of the formal period of training.

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