Hands On Astrophysics: Variable Stars In Math/Science Lab

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Variable stars (variables in short) are stars that change in brightness. They are interesting, numerous (over 30,000 known and another 15,000 suspected), and important because they reveal much of what we know about the properties, processes, and evolution of stars.

The American Association of Variable Star Observers (AAVSO): The discovery and measurement of the brightness of variable stars is simple in principle, and astronomy is helped significantly by the efforts of thousands of skilled amateur astronomers who measure variable stars in a systematic way. The AAVSO is a non-profit worldwide scientific and educational organization. The AAVSO is the largest organization of variable star observers in the world, with members in 43 countries. The purpose of the AAVSO is to coordinate variable star observing (done primarily by amateur astronomers), evaluate the accuracy of these observations, compile, digitize, and publish them and make them available to researchers and educators. Over 7.5 million observations of variable stars have been compiled since the AAVSO was founded in 1911. The scientific activities of the AAVSO are coordinated by the Director, who is a professional astronomer. The current Director is Dr. Janet A. Mattei.

Over 300,000 observations are submitted to the AAVSO by observers around the world each year. These observations are digitized and archived by the AAVSO in the AAVSO International Database. The AAVSO Director and her technical staff at AAVSO Headquarters (25 Birch Street, Cambridge, MA, USA 02138-1205; Tel.: (617) 354-0484; FAX: (617) 354-0665; E-mail: aavso@aavso.org) receive more than 200 requests annually from researchers and educators for AAVSO data and services. The number of requests has increased by a factor of 20 in the last two decades.

AAVSO services are sought by astronomers: (a) to receive real-time, up-to-date information on unusual stellar behavior; (b) to assist scheduling and execution of variable star observing programs using earth-based telescopes and instruments aboard satellites; (c) to request simultaneous optical coverage of stars being observed during earth-based or satellite observing programs, and immediate notification of their activity; (d) to correlate optical data with data obtained using other techniques (photometry, spectroscopy, polarimetry), and at other wave-lengths.
from gamma-rays to radio waves; (e) to carry out collaborative long-term data analysis of the behavior of (particularly) large amplitude variable stars; and (f) to assist educators in setting up observing projects, and students in carrying them out.

**Hands-On-Astrophysics – Variable Stars and Science/Math Education:** Variable star observation is simple, but the analysis and interpretation of the data involves a wide range of scientific and mathematical skills. Students can experience the excitement of doing real science with actual variable star data. Hands-On-Astrophysics: Variable Stars in Math/Science Lab. – being developed by the AAVSO and funded by the National Science Foundation – is an astronomy educational project which emphasizes student involvement and scientific discovery.

The project can be used at the high school level for lab exercises in physical science, mathematics, and computer sciences; for project work for science fairs or individual research projects; for summer courses and camps; and for science clubs. It can also be used, with some modification, at the college or university level, in introductory astronomy courses.

The Hands-On-Astrophysics project materials include: a manual with background reading and activities for the student, and concepts and application to curricula and examples of typical results for the teacher; 900,000 AAVSO observations extending 25 years on 70 variables in 5 seasonal northern hemisphere constellations; computer programs for data analysis; star charts for the 70 variables; a set of slides of the 5 constellations taken over a year; instructional videotapes on variable stars, variable star observing, and backyard astronomy; and a newsletter. All participants of the project will be linked via Internet.

Project activities include:

- identifying and measuring the brightness of variable stars in the real sky and on the slides;
- accessing and analyzing data in the database provided using the AAVSO computer programs or programs written by students
- plotting observations and interpreting the resulting graphs
- identifying different types of variable stars from their behavior
- analyzing the long term behavior (regularity, periodicity, etc.) of variable stars in the database.

Thus, by carrying out all aspects of the research process, students can develop and integrate a wide variety of skills in astronomy, physical sciences, mathematics, and computer science. The scientific and mathematical skills developed include: background reading and literature searching on the individual variable stars; understanding measurement and errors; analysis and interpretation of graphs; application of numerical techniques and statistics; data processing, analysis and graphing; interpretation of trends and changes; presentation of written and oral reports. In addition, through observing, the students develop an appreciation of the night sky and the skills of making variable star observations.

We expect that the Hands-On-Astrophysics project material will be available in 1997.

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