

AAVSO

Manual for Visual Observing of Variable Stars



Revised Edition
March 2013

The **American Association of Variable Star Observers**

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FOREWORD TO 2013 EDITION

It is with great pleasure that we present this revised and improved edition of the *Manual for Visual Observing of Variable Stars*. This manual is intended to be a comprehensive guide to variable star observing. This manual provides up-to-date information for making variable star observations and reporting them to the AAVSO, and was written by visual observing experts.

For new observers, this manual is an essential tool—the one place from which one can gather all the information needed in order to start a variable star observing program. Long-time and experienced observers, and those returning to variable star observing, on the other hand, may find it useful as a ready-reference, quick-resource, or refresher text to help explore new aspects of variable star observing.

This manual will familiarize you with the standardized processes and procedures of variable star observing—a very important part of making and submitting your observations to the AAVSO.

You will find here new information, presented in a useful format, with chapters grouped by subject-matter. There are several pull-out pages for those who prefer to put essential information in their own observing notebooks or under a plastic sleeve.

Whether you are a novice or an experienced observer, or even if you are just an armchair observer who wishes to learn more about variable star observing, we hope this manual will help you to increase your knowledge of the fundamentals of variable star observing, improve your work at the telescope, and help you to get more enjoyment and satisfaction from making a real contribution to the science of variable star astronomy.

The information in this manual has been collected from various AAVSO publications and was edited by Sara J. Beck, AAVSO Technical Staff. I sincerely thank Sara for the excellent job she has done in preparing this work.

In addition, many AAVSO members and HQ staff contributed valuable comments and recommendations to this manual. Many thanks to Carl Feehrer, Peter Guilbault, Gene Hanson, Haldun Menali, Paul Norris, John O'Neill, Ron Royer, Michael Saladyga, Mike Simonsen, Matthew Templeton, Elizabeth Waagen and Doug Welch.

Arne A. Henden
AAVSO Director

...it is a fact that only by the observation of variable stars can the amateur turn his modest equipment to practical use, and further to any great extent the pursuit of knowledge in its application to the noblest of the sciences.

—William Tyler Olcott, 1911

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INTRODUCTION

What are variable stars?

Variable stars are stars that change in brightness. Stars often vary in brightness when they are very young or when they are very old. The cause of variability may be intrinsic to the star (expansion, contraction, eruption, etc.), or may be due to extrinsic factors such as eclipses of two or more stars. Today, more a quarter million known or suspected variables have been catalogued. Most stars—including the Sun and the North Star—vary in brightness if measured precisely.

Why study variable stars?

The study of variable stars is really the study of the secret lives of stars. How are they formed, how they live out their lives and what changes occur internally and externally as they evolve. We learn about the environments surrounding them, including planets and other companions, and their affect on these partners; and finally, how they end their lives slowly fading away, stripped of their atmospheres or violently exploding, seeding the universe with the materials to build more stars, planets and us.

At almost every phase in a star's life it varies in its light output. If the variation is large enough and occurs on human timescales, we, the observers of the AAVSO, can record and study these changes, and we have now for over 100 years.

In that time we have learned about all kinds of variations in stellar output and how to interpret it. Some stars vary as they pulsate, actually changing size physically, growing and then shrinking again, sometimes with a precise period, sometimes irregularly. We've seen stars that appear to vary because star spots are transported across the face of the star as it rotates. We've witnessed stars being eclipsed by unseen companions in extremely close orbits around their center of gravity, and now we can see the incredibly small changes in the light of a star as a planet crosses in front of it from our point of view.

It is becoming apparent that the more we look, the more we will find planets around stars everywhere. It has also become obvious that the closer we look, the more we will find every star is a variable star to one degree or another at one time or another in its life.

What is the value of visual observations?

There has been a lot of discussion lately about what visual observers can do to make an honest contribution to science. What variable stars are really interesting to astronomers, and what observations are likely to lead to new understanding of the properties of these and other stars? It's no secret that with CCDs being capable of higher precision and numerous surveys covering the sky, with more coming online in the future, visual observers will have to be more selective about what they observe if they want to make a meaningful contribution to science. But there is still a lot the visual observer can do.

First, although a number of large instrumental surveys are currently active, they do not provide the same coverage that visual observers historically have. For one, few surveys fully cover the same brightness range available to visual observers; such coverage requires multiple surveys—smaller telescopes for brighter stars, and larger telescopes for fainter stars. For another, many surveys are single site, and so their coverage depends upon both weather conditions at the site and equipment reliability. Surveys also typically have a limited cadence of no more than a few data points per (local) night, meaning a target may only be observed for a small fraction of a day, if that. Finally, even surveys whose data are fully published do not necessarily guarantee permanent access to the light curves or other data products, and it is unlikely that any survey will ever operate in perpetuity—they are limited to the funding and staffing limitations of the researchers running the survey.

What is the AAVSO?

The American Association of Variable Star Observers (AAVSO) is a worldwide, nonprofit, scientific and educational organization of amateur and professional astronomers who are interested in variable stars. Founded in 1911 by William Tyler Olcott, an amateur astronomer and lawyer by profession, and Edward C. Pickering, Director of the Harvard College Observatory, the AAVSO was part of the Harvard College Observatory until 1954 when it became an independent, private research organization. Headquartered in Cambridge, Massachusetts, USA, its purpose was—and still is—to coordinate, collect, evaluate, analyze, publish, and archive variable star observations made largely by amateur astronomers, and to make these observations available to professional astronomers, educators, and students. In the year 2013, with over 1,100 members from 42 countries, it is the world's largest association of variable star observers.

In 2013, the archives of the AAVSO contained over 23 million observations on over 12,000 stars. Over 2,000 observers from around the world submit about a million observations every year. The observations are checked for errors and added to the AAVSO International Database. This database is a tribute to the skill, enthusiastic devotion, and dedication of AAVSO observers since 1911.

Services to the astronomical community

AAVSO data, both published and unpublished, are distributed to astronomers around the world via the AAVSO website (<http://www.aavso.org>) or upon request to AAVSO Headquarters. AAVSO services are sought by astronomers for the following purposes:

- a. Real-time, up-to-date information on unusual stellar activity;
- b. Assistance in scheduling and executing of variable star observing programs using earth-based large telescopes and instruments aboard satellites;
- c. Assistance in simultaneous optical observations of program stars and immediate notification of their activity during earth-based or satellite observing programs;
- d. Correlation of AAVSO optical data with spectroscopic, photometric, and polarimetric multi-wavelength data;
- e. Collaborative statistical analysis of stellar behavior using long-term AAVSO data.

Collaboration between the AAVSO and professional astronomers for real-time information or simultaneous optical observations has enabled the successful execution of many observing programs, particularly those using satellites for their research. These collaborative projects include observations by Apollo-Soyuz, HEAO 1 and 2, IUE, EXOSAT, HIPPARCOS, HST, RXTE, EUVE, Chandra, XMM-Newton, Gravity Probe B, CGRO, HETE-2, Swift, and INTEGRAL. A significant number of rare events have been observed with these satellites as a result of timely notification by the AAVSO.

Services to observers and educators

The AAVSO enables variable star observers to contribute vitally to astronomy by accepting their observations, incorporating them into the AAVSO data files, publishing them, and making them available to the professional astronomer. Incorporating your observations into the AAVSO International Database means that future researchers will have access to those observations, giving you the opportunity to contribute to the science of the future as well as the present.

Upon request, the AAVSO will help set up an appropriate observing program for an individual, an astronomy club, an elementary school, high school, college, etc. In this way, observers, students, and faculty are able to make the best use of their resources and to do valuable science. The AAVSO can also assist in teaching observing techniques and in suggesting stars to be included in a program.