

David Levy's Guide to Variable Stars

Variable stars are fascinating objects to observe! Found all over the sky, they change in brightness over time and can be seen with even the most basic of equipment. Variable star astronomy is one field in which amateur astronomers can still make significant contributions to science. In this highly accessible book, David Levy teaches the reader how variable stars work, and how to observe them. Using simple, non-technical terms he explains how to get started with electronic (or CCD) observing, as well as how to observe variable stars visually through a small telescope or binoculars. Including a section on southern hemisphere stars, the book covers various types of object that can be observed by amateur astronomers, including more exotic phenomena like gamma ray bursts, blazars, and polars. This book will motivate anyone with even a basic interest in astronomy to begin observing these fascinating objects.

DAVID LEVY is the author or editor of 31 books and other products. He is Science Editor for *Parade* magazine, and as a contributing editor for *Sky and Telescope* magazine he writes the monthly "Star Trails" column, and his "Nightfall" feature appears in each issue of the Canadian magazine *Skynews*. He has discovered 21 comets, eight of them using his own backyard telescopes, and he continues to search for comets both visually and with electronic telescopes. In collaboration with Eugene and Carolyn Shoemaker he discovered Shoemaker-Levy 9, the comet that collided with Jupiter in 1994, producing one of the most spectacular explosions ever witnessed in the Solar System. He won an Emmy in 1998 as part of the writing team for the Discovery Channel documentary, "Three Minutes to Impact." Levy resides in Vail, Arizona, with his wife Wendee, and together they host a weekly radio show, available worldwide at www.letstalkstars.com.

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To my Mother, Father, and Grandparents, who have shared many starlit nights with me, for Wendee, the star of my present, for our children and grandchildren, the bright stars of our future;

And in loving memory of Janet Mattei, director of the AAVSO – may your wisdom inspire many to reach for the stars.

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Foreword to the first edition

Variable star astronomy is one field in which an amateur astronomer can still make significant contributions to science. Regardless of the optical tool used, whether it is the naked eye, binoculars, a small or a large telescope, any lover of the stars can play an important role in our understanding of variable stars.

David Levy is truly a lover of stars. He is an avid observer and a discoverer of four comets, the second one found only forty minutes after he finished the final draft of this book! I have known David for over a decade as a member of the AAVSO and as a friend. His enthusiasm and his exuberance for astronomy has always impressed me. When David talks about variable stars, it is as if he is talking about his friends; they are not just stellar objects.

David is keenly aware of the difficulties that a new variable-star observer faces. He knows well that, in the beginning, locating variables and estimating their brightnesses takes lots of patience and perseverance. He also knows the joy one feels in making variable-star observations. Therefore, he makes every effort to find ways to get his reader interested in variable stars, and to make that first brightness estimate. He helps his reader to find out more about the sky, the wonderful seasonal progression of its appearance, about astronomy as it applies to variable stars, and finally more about the different types of variable stars and the individual members of each type.

David's book is an expression of love of the sky and of variable stars. I hope you will take the journey with David into this wonderful field, read about it, explore it, go out and observe, and feel the joy and the satisfaction of knowing that through your observations you are helping solve some of the mysteries of these stars.

Janet A. Mattei (1943–2004)

Preface

What do you see when you look through a telescope? Is it the mountains and valleys of a lunar highland, or perhaps a thinly veiled Jovian storm? Or do you prefer the ghostly light of the distant galaxies, island universes adrift in a sea of space and time? Perhaps you see the fluctuations of stars in our galaxy, stars of all ages whose nightly appearance changes according to some cosmic drumbeat whose rhythm we try to unravel.

A variable star is simply a star that changes in brightness. Observing variable stars is both useful to science, and fun. It is a field that needs the observations that dedicated amateurs with small telescopes have the time and enthusiasm to make. It will reciprocate as you contribute to it, for the more you observe the more you will learn about your subjects of observation.

The purpose of this book is to inspire you to observe variable stars. Through its pages, I want to share my enthusiasm for these distant suns that change in brightness. Accordingly the book's approach is to emphasize the observing, and to keep the scientific explanations simple.

Why do variables attract us? The answer lies in the stars themselves. These innocuous objects attract our interest because of their behavior, not their appearance. Although they do not look fascinating at first glance, consistent watching will draw out their surprises.

Variable stars reward the patient observer. A cycle of observing almost any Mira star will show why these stars are so interesting. As a long-period variable fades, it requires more and more telescope power to keep in touch. Week after week the star keeps on getting dimmer, giving you a feeling that you are about to witness its disappearance forever. Then one week you detect that the star's fading is slowing. You increase your frequency of observation to once every four days. Then comes a night when the star is actually brighter than before; it has passed its minimum and is now brightening. With each passing week its presence becomes more commanding as its reddish color stands out more and

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more among the neighbors in its field. In its approach to maximum, a Mira shines with pride.

When variable-star observing became popular in the early years of this century, the prospect of amateur observers adding something to our understanding of nature was the main attraction. In his hugely popular *Field Book of the Skies*, William Tyler Olcott invited his readers to become part of “the great work of astrophysical research” through a program that could be accomplished from their own backyards.

The stellar wind of research changes in direction. Where the careful monitoring of hundreds of long-period variable stars once was viewed as the major interest area for variables, today we follow other types as well. In 1920, few astronomers even knew about the stars that have periodic outbursts, the dwarf novae, which today are an important research field. And none of those astronomers would even have heard about such exotic things as gamma ray bursters, now a rapidly evolving field for amateur variable-star observers. A program for beginners today includes a mixture of Mira-type stars, dwarf novae, eclipsing binary stars and other stars whose light fluctuations are worth noting. Astronomy is a dynamic, evolving science, and the types of variables we add to our programs reflect this changing scene. In learning the periods and the long-term behavior of many variable stars, the visual observations we make are sufficient. In three-quarters of a century, the American Association of Variable Star Observers (AAVSO) has gathered near-continuous records of the behavior of many stars. When astronomers wish to learn the case history of a star, when they want to plan their observing programs, they rely on these data.

Quite aside from their scientific interest, the cyclic patterns of variable stars are fun to watch. We observe variables for science, but also for sport. With each night of observation, a variable star observer has looked at the sky, and taken its pulse.

First Night

Imagine that “party from hell” where you walk into a strange house and trip over a table, spilling drinks on all the other guests? The first time I spent a night outside trying to estimate the brightness of a variable star was such an experience. I resolved never to look at one again. The star I chose for that ill-fated night was Chi Cygni, a famous long-period variable, which at maximum can often be seen clearly. But on this night, Chi Cygni was nowhere near maximum, and at 13th magnitude it was completely lost in a sea of very faint Milky Way stars. It was the *worst* choice – a faint star in a field of many faint stars. I wasn’t

sure that Chi Cygni would be very bright that night, but I certainly didn't expect it to be as faint as that.

Yet today, this uncertainty about how bright a variable is going to be has become the main reason I keep observing them. They always offer surprises. Occasionally, an unexpectedly faint minimum will remind me of that long night with Chi Cygni.

I begin observing each night in a mood of suspense. What has changed since the last time I was outside? The first thing I do is to take a quick glance over the entire sky to see if any new novae, or exploding stars, have appeared. Tonight I shall check the sky down to the 3rd magnitude, just to see.

But wait! What's there? On the long arm of Cygnus – an extra star? Yes, it's my old friend Chi Cygni again, now bright and visible without even binoculars. Chi is an example of a long-period variable.

In a year, I can watch a number of such stars pass through complete cycles of variation, occasionally stretching through as much as eight magnitudes on each side. Although the maximum and minimum of long-period variables can be predicted with some confidence up to a year in advance, it is up to amateur observers like you and me to spot humps and small standstills in the light curves of some of these stars.

These are variable stars, and we are their watchers. Serious observing is like playing or composing music. To get the most out of these activities takes heart and soul. The mere thought of doing it gives you a pleasant feeling and a twinkle in your eye, but when you first put eye to eyepiece, or finger to keyboard, or pen to paper, your whole being is filled with a special satisfaction. With variables, this joy has the added dimension of being a part of what is happening away from home.

Acknowledgments

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