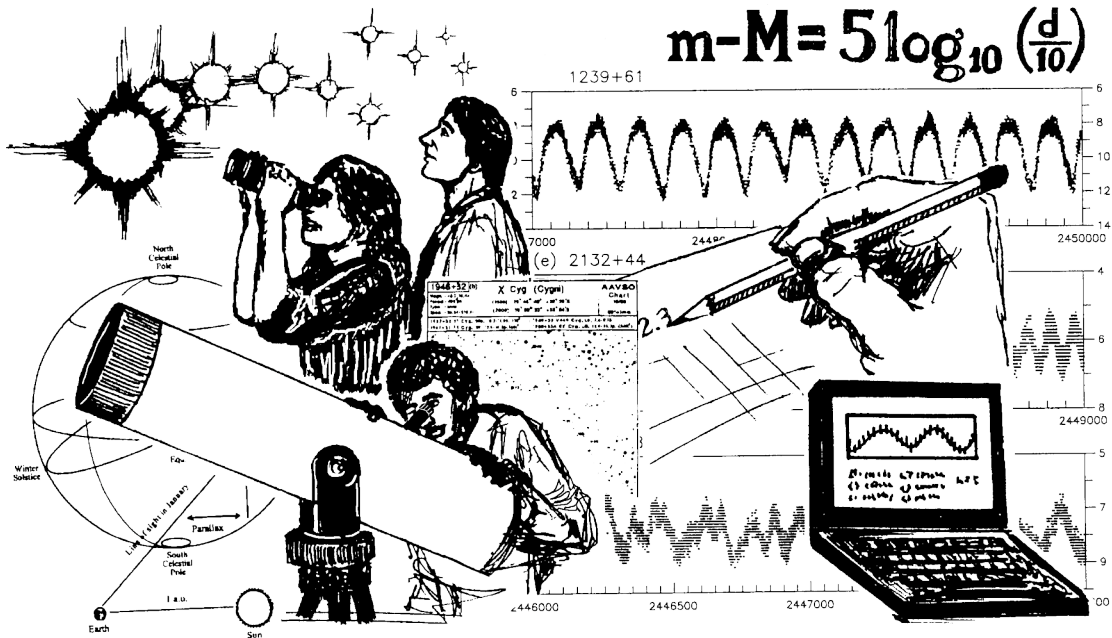


AAVSO Variable Star Astronomy

Web version of Hands-On Astrophysics



An educational program created by
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Preface

Through the years, the American Association of Variable Star Observers (AAVSO) has been a source of information and guidance to students who decide to study variable stars for class or science fair projects. The idea to develop a formal curriculum using the AAVSO's unique variable star database, however, came about when I attended "An Education Initiative in Astronomy" workshop, supported by NASA, in Washington, DC, in February of 1990. The opportunities, objectives, strategies, and recommendations that were discussed at that workshop, along with the presentation by Dr. Bassam Z. Shakhashiri, then Director of the National Science Foundation's Education Division, who suggested that we as astronomy educators have the best tools to attract the attention and imagination of students, other teachers, and the public, provided the impetus and ideas for *Hands-On Astrophysics*.

My colleague John R. Percy, a leading advocate of astronomy education for decades, had been using AAVSO variable star observations in many projects for his students at the University of Toronto. Inspired by the Washington, DC, workshop, Dr. Percy and I, with the strong endorsement of the AAVSO Council, decided to develop together a curriculum—*Hands-On Astrophysics*—based on our many years of experience in guiding students, and utilizing many decades of AAVSO variable star observations.

Variable stars are stars that change in brightness, and these changes in brightness help us understand the nature and evolution of stars and galaxies. The study of variable stars is particularly suited to science, math, and computer education. Students can observe variable stars with binoculars, telescopes, and even with the unaided eye, and then can analyze the changes in brightness of the stars they observe by using the over 600,000 observations and the computer programs provided with *Hands-On Astrophysics*. As students discover the unique qualities and the oddities of a star's behavior, they can find out more about "their star" through further research in the library and via the Internet.

With members in 45 countries, the AAVSO is the largest organization in the world dedicated to variable stars, and with over 8.5 million variable star observations from its founding in 1911 to the present, the AAVSO is custodian of the world's largest database on variable stars. Many variable star observing groups around the world submit their observations to the AAVSO to be part of the AAVSO International Database, so they can be used by researchers and educators around the world. AAVSO members and observers range in age from eight to over 90, and come from all walks of life, but they all have one thing in common: a love of and curiosity about variable stars. These dedicated amateur astronomers have provided the unique component of the *Hands-On Astrophysics* curriculum—real data which can be used by students, teachers, and amateur and professional astronomers alike to discover the secrets of the stars, including our own Sun.

All components of the *Hands-On Astrophysics* curriculum were designed with the discovery process in mind. Our intention in offering this curriculum to you is to help students acquire fundamental science skills and to develop an understanding of basic astronomy concepts, to provide interdisciplinary connections, and to take students through the whole scientific process. It is our hope that while having fun in working with real data, students will develop more sophisticated math and computer skills. We further hope that *Hands-On Astrophysics* will foster among both students and teachers a love of and interest in one of the most fascinating branches of science—astronomy.

Hands-On Astrophysics is not just for students and teachers: it has been developed for everyone who is interested in astronomy and in learning more about the wonders and workings of the universe. HOA materials are suitable for amateur astronomers who wish to learn more about the fascinating nature of variable stars. There is a wealth of information which can be utilized for science projects, for astronomy club activities, and for family learning.

As Co-Directors of HOA, John Percy and I gratefully acknowledge the funding provided to the AAVSO by the Education Division of the National Science Foundation (NSF) through Grant No. ESI-9154091, which enabled us to develop this curriculum. We express our sincere thanks to Dr. Gerhard L. Salinger, NSF Instructional Materials Development Program Director, who recognized the potential of our project and provided us with his invaluable guidance and recommendations throughout its development.

We express our gratitude to the thousands of amateur astronomers worldwide who contributed observations to the AAVSO International Database—without their efforts we would not have the real data on which the HOA curriculum is based.

Finally, we recognize with deepest appreciation the efforts of Donna L. Young, lead teacher and principal author of the HOA Manual, and the invaluable contributions of many teachers, students, amateur astronomers, AAVSO staff members, and other individuals to the development of *Hands-On Astrophysics*.

Janet Akyüz Mattei
AAVSO Director

Cambridge, Massachusetts, USA
December 1997

Foreword

In November of 1996, I attended the second *Hands-On Astrophysics* (HOA) teachers' workshop held at the Headquarters of the American Association of Variable Star Observers (AAVSO) in Cambridge, Massachusetts. At the time I was teaching astrophysics and AP physics at the Maine School of Science and Mathematics in Limestone, Maine (a new residential math and science magnet school for juniors and seniors). I was looking for that nonexistent middle-ground material for my astrophysics class—halfway between basic introductory astronomy content and calculus-intensive astrophysics. During that workshop, as I considered the preliminary HOA materials before me, I decided that the concept of variable star observation had the potential to be a truly innovative and exciting curriculum. I went back to the magnet school and introduced my students to the process of estimating magnitudes, plotting light curves, and constructing phase diagrams with the VSTAR software.

In northern Maine in the middle of winter, early evening temperatures are often -25 to 35°F. But the night sky is stunningly beautiful with frequent aurorae and myriad stars, and the winter cold did not deter my students. I literally could not stop some of them from making their nightly observations. Seeing their enthusiasm, the idea passed through my mind that I would like to develop some classroom materials for teachers based on what the AAVSO had begun.

A few months later I was granted a yearlong residential fellowship at the Wright Center for Innovative Science at Tufts University, directed by Eric Chaisson. At the same time, AAVSO Director Janet Mattei asked if I would be interested in working as a development consultant for the HOA curriculum, thereby contributing the perspective of a recognized master classroom teacher with extensive experience in state science initiatives and national workshops. I decided that my project for the year at the Wright Center would be *Hands-On Astrophysics*.

The more involved I became with HOA, the more excited I became over the potential that the curriculum held for so many students and teachers. For the past year and a half I have been extensively involved in rewriting some preexisting materials and making copious additions to the manual. I have made every attempt to ensure that the manual is as easy to use as possible for classroom teachers, and is as interesting as possible for students, amateur astronomers, and other individuals.

The HOA curriculum will not work for content-driven courses. Instead, it is a self-directed study, with minimal input from teachers, which involves students in real science. There is nothing artificial or arbitrary or contrived. *Hands-On Astrophysics* students will do science in exactly the same way that professional scientists do science every single day. There are no right or wrong answers: the process is everything. The content is assimilated along the way as necessary, not presented as long and tedious text. This curriculum empowers students to take charge of a learning process that is applicable to every facet of their lives, whether educational or personal. No other science is as interesting or fascinating as astronomy, and doing astronomy is more interesting and fascinating than reading about it. Students can gain incredible insight into the scientific process with nothing more than their eyes and the contents of this curriculum.

Hands-On Astrophysics is an invitation to embark upon a journey into the very hearts of stars—to listen to the rhythms of their pulsations, and begin to gain an understanding of the processes by which they evolve. Along the way, students will acquire the necessary

skills and knowledge to determine and comprehend the message encoded within starlight, but the strength and power of the journey is that it involves a complete immersion into the scientific process—the very foundation of how we construct knowledge. Those who undertake this journey will also realize an added benefit: an appreciation of the stellar inhabitants of our universe that may result in a lifelong avocation as an amateur astronomer, with the potential of making significant contributions to science.

Finally, *Hands-On Astrophysics* takes students out of the artificial confines of classroom walls to gather observational data from the night sky above them. This is where they will begin their own individual journeys to the stars and feel the same deep stirrings that our ancestors felt when they looked towards the stars. We have not lost our fascination for the night sky. The colored and dancing display overhead causes us to pause and reflect, invoking deep longings that take us back through millennia and connect us to our past. Our origins are in the stars, and so is our future. When we look up we feel connected to the grandeur of the sparkling array above us. And that is the final powerful interdisciplinary aspect of this curriculum—that both people and stars are connected, occupying their own places in time and space, living and dying together in the same universe.

I am proud to have had the opportunity to help in the development of *Hands-On Astrophysics*. I hope it has a major impact on astronomy education worldwide.

Donna L. Young
HOA Manual Author
Curriculum Consultant

Medford, Massachusetts, USA
December 1997

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CAUTIONARY SAFETY NOTE

1. Students should NEVER look directly at the Sun, especially when using binoculars or telescopes. The ultraviolet radiation from the Sun will damage the delicate cones and rods of the eye and can cause blindness. If students do not have specialized filters for solar observations provided or approved by their instructors, they should project the image of the Sun on the ground or a piece of paper.
2. Special precautions need to be taken for nighttime observations, whether at home or at school. Students should NEVER travel to or work alone in isolated areas. Make sure that the observational sites selected are safe, and always work with others. Inspect the chosen sites carefully, making note of any potential sources of danger such as construction areas, broken glass, etc. If working with power-driven telescopes outdoors, make sure that extension cords are properly grounded. If a site is located on private property, be sure to obtain permission (preferably written) from the owner ahead of time.
3. Parents or guardians of students should be informed of any assignments that students are required to do involving the observation of the sky, especially late at night. The proper school authorities should be notified, and permission slips signed by parents of younger students. Depending upon the age level of the students, one or more adults should accompany the group, such as parents, local astronomy groups, or amateur astronomers.