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## The Cambridge Encyclopedia of Stars

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This unique encyclopedia provides a fascinating and fully comprehensive description of stars and their natures and is filled with beautiful color images. The book begins with ancient astronomy – with constellations and star names – and then proceeds to modern coordinate systems. Further chapters explain magnitudes, distances, motions, and the Galaxy at large. Double stars, clusters, and variables are introduced, and, once the different kinds of stars are in place, later chapters examine stellar evolution, beginning with the interstellar medium and star formation, proceeding to our Sun and its characteristics, and ending with the ageing processes of solar-type and high-mass stars. The book ends by showing how this information can be combined into a grand synthesis. Detailed cross-referencing enables the reader to explore topics in depth and makes this an invaluable work both for beginners and for those with a more advanced interest in stars and stellar evolution.

DR. JAMES B. KALER is Professor Emeritus of Astronomy at the University of Illinois at Urbana-Champaign. His research involved dying stars, specifically the graceful shells and rings of gas ejected in stellar death called “planetary nebulae.” Long interested in science education and popularization, Dr. Kaler has written for a variety of magazines that include *l’Astronomia* (Italy), *Astronomy*, *Sky and Telescope*, *StarDate*, and *Scientific American*. He was a consultant for Time-Life Books on their “Voyage Through the Universe” series, has appeared frequently on regional Illinois television and radio, and lectures widely. He received the 1999 Armand Spitz Memorial Lectureship from the Great Lakes Planetarium Association for his work, has written several books including *Stars and their Spectra*, *Extreme Stars: At the Edge of Creation*, and *The Ever-Changing Sky: A Guide to the Celestial Sphere*, all published by Cambridge University Press. Dr. Kaler has an asteroid named after him in honor of his outreach work.

# THE CAMBRIDGE ENCYCLOPEDIA OF STARS

James B. Kaler



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**To my Family**

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## Preface

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In the summer of 1947, when I was eight years old, I wrote a five-page “book” called “Things That I Know About Stars.” It calls out some of the constellations I had found. And it contains a few gems: “The Sun may expand to about 3 or 4 times its size”; “There are two kinds of stars (dwarfs and giants)”; “A white dwarf may enter the solar system”; [The Sun] “is a fixed star traveling at about 12 miles per second [sic].” I have no idea where these came from: eight-year-olds are not much into citations. And I clearly could have used an editor. But the statements are, even after nearly 60 years, all basically true.

I’m still writing the same book. It’s just become a little bigger. I also found an editor. And it is not what I know, but what generations of astronomers have learned and allowed us all to know about the stellar science. Decades of research have not only supported the knowledge of the 1940s and earlier, but have added to it to an astonishing degree, to the point at which we have a good understanding of the beasts of the stellar zoo, and how they all link together. That is hardly to say that we have found all the answers. Indeed, for every discovery, there seems to unfold another mystery.

*The Cambridge Encyclopedia of Stars* is not laid out in traditional encyclopedic – alphabetic – format. Nor is it designed as a pedagogical textbook in which one chapter leads smoothly and logically into the next. It falls instead somewhere in between. Chapters concentrate on particular aspects of stellar astronomy – distances, double stars – and are meant to stand alone. At the same time, the reader is led continuously deeper and deeper into the subject. Discussion in one chapter assumes knowledge to be found in other chapters. Continuity is achieved by using both forward and backward referencing. For example, the chapter on distances discusses the Cepheid variable method, but does not treat either their creation or

structure, which are reserved for later chapters and sections, and which are referenced with square brackets. The book is designed such that a reader can pursue it either from beginning to end or can dip into it at any point and read any particular chapter, in either case referring to the cross-referencing as needed.

*The Cambridge Encyclopedia of Stars* begins with two chapters on astronomical fundamentals that discuss constellations, star names, and coordinates. These are followed by another pair that examine stellar fundamentals: magnitudes and distances. An interlude places stars within the context of the Galaxy by looking at solar and stellar motions. The next pair attack the spectral sequence, the HR diagram, the various kinds of stars, and physical properties such as temperature, chemical composition, and the like. A trio then discusses binary systems, clusters, and variable stars. With these stellar characteristics in place, the book concludes with a set of four chapters on stellar structure and evolution that examine the interstellar medium and star formation, the Sun and the main sequence, the evolution of lower mass stars to white dwarfs, the evolution of higher masses to neutron stars and black holes.

Though the format is largely descriptive, equations are used where they enhance clear discussion. Calculus is not employed except by discussion of it in the section on stellar structure, in which the concepts are developed. Background and peripheral material is placed into boxed sidebars. The biggest problem, as always, was the selection of what to include within the limits of space allotted. I have tried to bring a balance to the book by maintaining what I consider to be consistent levels from one chapter to the next to give an overall uniform view of what is known about stars, and equally important, what is not known. I hope you enjoy the results.



## Acknowledgements

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As in any page of acknowledgements, especially for a book of this scope, there are many sets of people to thank. Foremost are the research astronomers who through their hard and dedicated work gleaned the knowledge that is presented here. The data in the many tables that appear in the text and appendices are a synthesis of a vast number of compilations and research papers by generations of scientists. Deep thanks and appreciation to them all.

Next are the individuals who made this labor of love possible. First to thank is Simon Mitton, who was responsible for getting the project started in the first place at the January 2001 meeting of the American Astronomical Society in San Diego. We were discussing the Cambridge encyclopedia projects, and I said “How about one on stars?”. Four years later, the work was finally complete. To Simon, thanks. Following closely are my editor, Jacqueline Garget, who has patiently followed my progress through the forest of stellar astronomy, and has guided the book to fulfillment. Thanks also to editors Vince Higgs and Jo Bottrill, copy editor Peter Sinclair, and to designer Chris McLeod. I express great thanks as well for the fine new graphics rendered by Precision Graphics of Champaign, and for their diligence in preserving the old ones.

Third are the many professional and amateur astronomers who have allowed me the use of their wonderful imagery and who have helped make the book come alive. Following are the various observatories and organizations (and their personnel) who have been kindly cooperative and that include the American Association of Variable Star Observers (AAVSO), the Anglo-Australian Observatory, Big Bear Solar Observatory, the California Institute of Technology (Mt. Wilson and Palomar), the Chandra X-ray Observatory, the Institute for Solar Physics, Royal Swedish Academy of Sciences, Lick Observatory, Lowell Observatory, the National Optical Astronomy Observatories (NOAO), the Okayama Astrophysical Observatory, the Space Telescope Science Institute (Hubble Space Telescope, HST), the Subaru Telescope, and Yerkes Observatory. Thanks also to Sky Publishing Company and to the Special Collections and Rare Book Room of the University of Illinois. A very special thanks goes to Adam Black and to Addison-Wesley for allowing the use of numerous graphics from my textbook *Astronomy!*.

Last and hardly least are the many astronomers who taught me their craft, patiently answered my questions, and set me on corrected paths. Thanks to you all.

