The Life and Death of Stars

In this well-illustrated text, Kenneth R. Lang explains the life cycle of stars, from the dense molecular clouds that are stellar nurseries to the enigmatic nebulae that some stars leave behind in their violent ends. Free of mathematical equations and technical jargon, Lang’s lively and accessible text provides physical insights into how stars such as our Sun are born, what fuels them and keeps them bright, how they evolve, and the processes by which they eventually die. The book demonstrates the sheer scope and variety of stellar phenomena in the context of the universe as a whole. Boxed focus elements enhance and amplify the discussion for readers who want more depth. Featuring more than 150 figures, including color plates, The Life and Death of Stars is a modern and up-to-date account of stars written for a broad audience, from armchair astronomers and popular-science readers to students and teachers of science.

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Preface

How did the Sun and other stars come into being, what keeps them hot and makes them shine, how do they change with time, and what will be their ultimate fate? These are questions of interest to people of all ages; this book, *The Life and Death of Stars*, provides a lively and comfortably accessible account of them.

It begins with a discussion of radiation, which carries a message from the stars and tells us just about everything we know about them. The text continues with a description of gravity, which rules the universe, and the motion that holds everything up. We then take a voyage inside the atom to discover the subatomic particles that govern how energy is liberated inside stars, including the related topic of radioactive transformation of the elements. Heat, temperature, and pressure also are vital to our understanding of the interiors of the stars and their birth, growth, and decay.

These fundamental physical concepts provide the foundation for what follows, which is the approach that George Gamow used more than a half-century ago in his classic account of *The Birth and Death of the Sun*. This book made a tremendous impression and inspired an entire generation, but many of its conclusions are completely out of date. Although consistent with what was known at the time, subsequent improvements in our knowledge have shown that Gamow was misled about the dominant nuclear reactions in the Sun, the course of stellar evolution, and the origin of the elements. However, he had a marvelous physical insight and applied fundamental physics to our understanding of the Sun, without an equation in sight.

This book, *The Life and Death of Stars*, is written in a light and friendly style that can be appreciated by all readers, without being unnecessarily weighed down by specialized material, scientific jargon, or mathematical equations. Throughout this book, the basic concepts are translated into a common language with apt, down-to-earth metaphors and analogies, making them accessible to general readers and adding to the material. The text also is humanized with historical anecdotes about significant contributors to our celestial science.

Separate focus elements enhance and amplify the discussion with interesting details. Vital facts and physical information are presented in numerous tables. The focus elements and tables will be read or used by an especially curious person or serious student; however, they do not interfere with the general flow of the text and can be bypassed by readers who want to follow the main ideas.
Preface

There also are excellent line drawings, prepared by Kacha Bradonjich, and stunning images from the ground and space that help cement our newfound knowledge. They help crystallize a new concept with a visual excitement that adds another dimension to our understanding.

The book provides a comprehensive account of the enormous recent advances in our detailed understanding of the Sun using instruments aboard spacecraft. Sound waves have been used to peer deep within the Sun, and invisible x-rays have been employed to investigate its million-degree outer atmosphere. The mismatch between the observed and expected amounts of the ghostlike neutrinos has been resolved using massive underground detectors. These results all serve to confirm and embellish our understanding of how energy is generated by nuclear reactions at the center of the Sun and transported to its glowing disk that warms our ground, lights our days, and sustains life on the Earth. The Life and Death of Stars also describes how explosions on the Sun and powerful gusts in its supersonic winds interact with our planet, threatening humans and satellites in nearby space.

In the past few decades, our knowledge of all the other stars also has expanded enormously. The book portrays the tremendous range in how bright, luminous, hot, big, and massive the stars are. It also describes the nuclear reactions that keep different stars hot and luminous and how this is related to their growth and transformation. We place the Sun within this story of stellar lives and demonstrate how the life and death of former stars, which lived and died before the Sun was born, resulted in the creation of elements required for the very existence of the Earth and people living on it.

Star birth and death are continuing before our very eyes. We can see how new stars arise from interstellar material and detect planets around those nearby. Stellar destinies are just as fascinating, for dying stars do not simply disappear. They are reborn in another form, as white dwarfs, neutron stars, or black holes.

This brings The Life and Death of Stars to the larger questions of what lies beyond the stars and how the first stars began. Here, the book provides a concise account of the observable universe, which was propelled into expansion by “the big bang.” We are still immersed within its background radiation, which is now being scrutinized with instruments aboard spacecraft. The text then wonders how it all began and explores the ultimate destiny of the stars, when they all will cease to shine.

This book tells a story of discovery and the wonderful, exciting diversity of the stellar universe. It is an amazing collective portrait of birth, transformation, decay, and rebirth. The Life and Death of Stars also provides for readers the background needed for a greater understanding and appreciation of those inevitable, currently unknown, celestial discoveries that will unfold during their lifetime.

The author also writes more advanced texts that include mathematical equations and references to original research papers and comprehensive up-to-date reviews. For this complementary approach, the reader is referred to Essential Astrophysics (New York: Springer, 2013).

Special gratitude is extended to my friend and neighbor Paul Strauss for his encouragement and careful reading of the page proof.

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