Cosmology

Advances in science have greatly changed our ideas on the nature of the universe. *Cosmology: The Science of the Universe* is a broad and elementary introduction to cosmology that includes aspects of its history, theology, and philosophy. The book explores the realm of receding galaxies, the fascinating properties of space and time, the bizarre world of black holes, the astonishing expansion of the universe, the elegant simplicity of cosmic redshifts, and the momentous issues of inflation. Its subjects cover modern views on the origin of atoms, galaxies, life, and the universe itself; they range from the subatomic to the extragalactic, from the beginning to the end of time, and from terrestrial to extraterrestrial life. Old problems (e.g., the cosmic-edge) are revived and new perplexities (e.g., the containment riddle) are reviewed. In this unique book, Professor Harrison shows how in every age societies devise universes that make sense of the human experience. He explores the cosmic scenery of the Babylonian, Pythagorean, Aristotelian, Stoic, Epicurean, Medieval, Cartesian, and Newtonian world systems and shows how these and other systems laid the foundations of the modern physical universe.

The first edition of this best-selling book received world-wide acclaim for its far ranging treatment and clarity of explanation. This eagerly awaited second edition updates and extends the first edition. The additional chapters discuss *Early Scientific Cosmology*, *Cartesian and Newtonian World Systems*, *Cosmology After Newton and Before Einstein*, *Observational Cosmology*, *Inflation*, and *Creation of the Universe*.

EDWARD HARRISON, distinguished university professor emeritus of physics and astronomy at the University of Massachusetts, was born in London at the end of World War I. He studied at London University and served for several years in action with the British Army in World War II. He was a scientist at the Atomic Energy Research Establishment and the Rutherford High Energy Laboratory in England until 1966 when he became a Five College professor at the University of Massachusetts and taught at Amherst, Hampshire, Mount Holyoke, and Smith Colleges. Professor Harrison is author of *The Masks of the Universe* (which gained the Melcher Award), *Darkness at Night: A Riddle of the Universe*, and numerous scientific articles that have contributed to the advance of modern cosmology. He has also written many articles on the history and philosophy of early cosmology. He is married to Photeni, has two children, John-Peter and June Zöe, and is now adjunct professor at the Steward Observatory, University of Arizona.

Cosmology

THE SCIENCE OF THE UNIVERSE

SECOND EDITION

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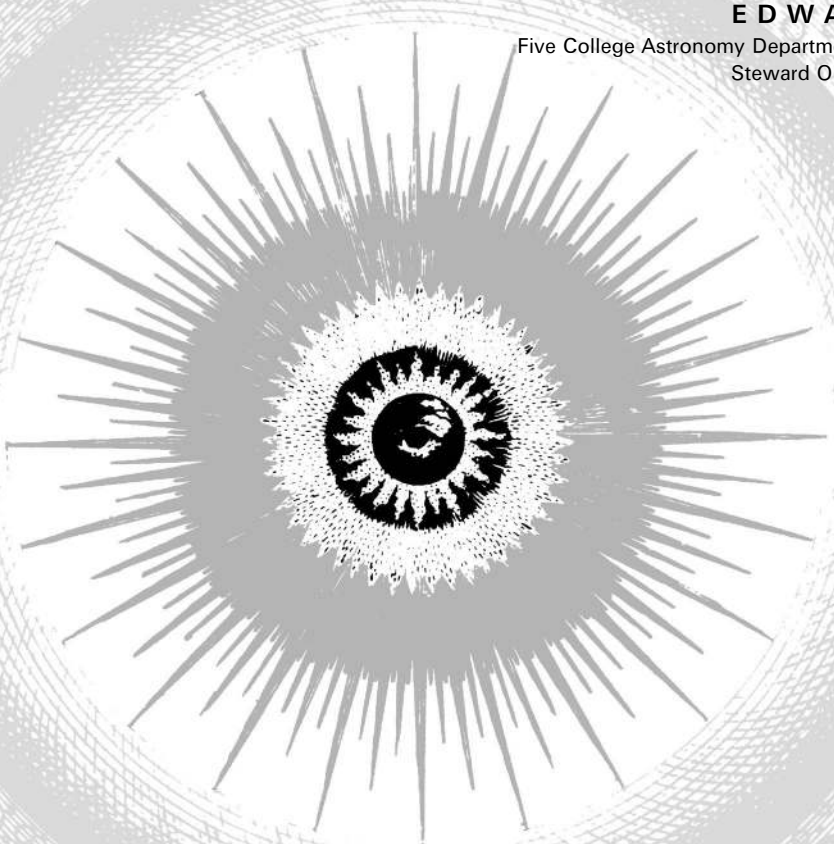

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PREFACE

This second edition of *Cosmology: The Science of the Universe* revises and extends the first edition published in 1981. Much has happened since the first edition; many developments have occurred, and cosmology has become a wider field of research.

As before, the treatment is elementary yet broad in scope, and the aim is to present an outline that appeals to the thoughtful person at a level not requiring an advanced knowledge in the natural sciences. Cosmology has many faces, scientific and nonscientific; in this work the primary emphasis is on cosmology as a science, but the important historical, philosophical, and theological aspects are not ignored. Mathematics is avoided except in a few places, mostly at the end of chapters, and the treatment is varied enough to meet the needs of both those who enjoy and do not enjoy mathematics.

At the end of each chapter are two sections entitled *Reflections* and *Projects*. The Reflections section presents topics for reflection and discussion. The Projects section raises questions and issues that a challenged reader might care to tackle. Cosmology impels us to ask deep questions, read widely, and think deeply. It is not the sort of subject that lends itself readily to simple yes and no answers. On most issues there are conflicting arguments to be investigated, weighed, rejected, accepted, or modified according to one's personal tastes and beliefs. Cosmology challenges the mind, shapes our way of thinking about the world in which we live, and leaves impressions and ideas that last a lifetime.

Many texts on cosmology and general relativity tend to be too technical for college students and nonspecialists. Numerous less-technical treatments now exist that are often too brief and of insufficient scope and depth for a course of study. At the end of each chapter are suggestions for further reading to help the reader explore alternative treatments (sometimes in greater depth and detail) of the subjects discussed in the chapter. Also provided is a list of sources containing references that are usually readable and not too technical; the few that are more technical are included for their historical interest.

The first edition of this book evolved from class notes used for teaching elementary cosmology in the Five College Astronomy Department of Amherst College, Hampshire College, Mount Holyoke College, Smith College, and the University of Massachusetts. At that time the method of grading consisted of brief weekly papers, mostly on topics (germane to the lectures) of each student's choice. It was evident that a text of broad scope was needed that might hold the attention of students of different backgrounds and interests, and provide the information needed for discussions and the preparation of papers. After the publication of the first edition, the method of grading changed and consisted of four equally spaced take-home examinations

followed by an end-of-semester examination. Many questions included in the examinations did not require mathematical skills. Both methods of grading have their advantages and disadvantages. There must be a better way!

I am indebted to many persons for their comments and helpful suggestions, particularly Thomas Arny (University of Massachusetts, Amherst), Gregory Benford (University of California, Irvine), Robert Brandenberger (Brown University), Mario Bunge (McGill University), Thomas Dennis (Mount Holyoke College), James Ellern (University of Southern California, Los Angeles), George Ellis (University of Capetown), Stephen Gottesman (University of Florida, Gainsville), George Greenstein (Amherst College), Gary Hinshaw (NASA/Goddard Space Flight Center), Paul Hodge (University of Washington), Duane Howells (Hughs Research Laboratories), John Huchra (Harvard–Smithsonian Center for Astrophysics), John Lathrop, Charles Leffert, William McCrea (University of Sussex), A. J. Meadows (Loughborough University of Technology), Heinz Pagels (University of California, Santa Cruz), Joel Primack (University of California, Santa Cruz), Martin Rees (Cambridge University), Joe Rosen (University of Central Arkansas), Rick Shafer (NASA/Goddard Space Flight Center), Stephen Schneider (University of Massachusetts, Amherst), Joseph Snider (Oberlin College), Joseph Tenn (Sonoma State University), Virginia Trimble (University of California, Irvine), David Van Blerkom (University of Massachusetts, Amherst), Gerard de Vaucouleurs (University of Texas, Austin), and Robert Wilson (Smithsonian Astrophysical Observatory).

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EDWARD HARRISON
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