Quantum Big Bang Cosmology

The great debate over the Big Bang and the quest to understand the fate of the universe Today, the Big Bang is so entrenched in our understanding of the cosmos that to doubt it would seem crazy. But as Paul Halpern shows in Flashes of Creation, just decades ago its mere mention caused sparks to fly. At the center of the debate were Russian American physicist George Gamow and British astrophysicist Fred Hoyle. Gamow insisted that a fiery explosion explained how the elements of the universe were created. Attacking the idea as half-baked, Hoyle countered that the universe was engaged in a never-ending process of creation. The battle was fierce. In the end, Gamow turned out to be right -- mostly -- and Hoyle, along with his many achievements, is remembered for giving the theory the silliest possible name: "The Big Bang." Halpern captures the brilliance of both thinkers and reminds us that even those proved wrong have much to teach us about boldness, imagination, and the universe itself.

This groundbreaking book develops a new form of quantum theory. First there was quantum mechanics. Then there was quantum field theory. Now we have quantum theory of the third kind: a new form of quantum field theory with quantum coordinates in the imaginary part of a complex space-time. This book is

the second edition of ?A Finite Unified Quantum Field Theory of the Elementary Particle Standard Model and Quantum Gravity? with major additions on unitarity, relativistic invariance and the nature of space-time. Some major new results in this books are: A Unified Theory of QED, Weak Interactions, Strong Interactions and Quantum Gravity; A General Formulation of Divergence-free Quantum Field Theories (Detailed discussions of unitarity and special relativity showing these theories are physically acceptable.). A divergence-free quantum field theory for massive vector bosons: No need for the Higgs mechanism. The "Low Energy" Limit of elementary particle sector of unified theory approximates the Standard Model (& QED) to extreme accuracy. It suggests possible doubly charged dilepton, and other exotic, resonances. The "Large Distance", classical limit of Quantum Gravity sector is General Relativity. It suggests no ultra-light Black Holes exist. Gravity is repulsive (anti-gravity) at ultra-short distances. Two-tier gravity ?saves? the concept of a space-time point by evading Wigner?s classic argument against it. Based on experimental data a preferred local reference frame defined by Cosmic Background Radiation is shown to exist in each locale. (Preferred local inertial frames are used in two-tier quantum gravity whose dynamical equations are invariant under general relativistic transformations but whose ?ground state? breaks the invariance down to invariance under special

relativity.) A New form of hidden dimensions is defined ? Quantum Dimensions ? dimensions implemented via a quantum gauge field. A New method in the Calculus of Variations ? composition of extrema ? is described.

In the last years we have witnessed how the field of Cosmology has experienced a metamorphosis. From being essentially the search for three numbers (the expansion rate, the deceleration parameter, and the cosmological constant), it has become a precision science. This scientific discipline is determined to unravel the most minute details of the elementary processes that took place during the most primitive stages of the Universe and also of the mechanisms driving the cosmic expansion and the growth of structures at the largest scales. To achieve these goals one needs not only the development of new experimental and observational techniques but also a deep understanding of the underlying theoretical frameworks. This book gathers the work of leading experts in these fields and provides a broad view of some of the most relevant open questions faced by Cosmology at the beginning of the twenty-first century.

Advances made by physicists in understanding matter, space, and time and by astronomers in understanding the universe as a whole have closely intertwined the question being asked about the universe at its two extremesâ€"the very large and the very small. This report identifies 11 key questions that have a good

chance to be answered in the next decade. It urges that a new research strategy be created that brings to bear the techniques of both astronomy and sub-atomic physics in a cross-disciplinary way to address these questions. The report presents seven recommendations to facilitate the necessary research and development coordination. These recommendations identify key priorities for future scientific projects critical for realizing these scientific opportunities. Contemporary science presents us with the remarkable theory that the universe began to exist about fifteen billion years ago with a cataclysmic explosion called `the Big Bang'. The question of whether Big Bang cosmology supports theism or atheism has long been a matter of discussion among the general public and in popular science books, but has received scant attention from philosophers. This book sets out to fill this gap by means of a sustained debate between two philosophers, William Lane Craig and Quentin Smith, who defend opposing positions. Craig argues that the Big Bang that began the universe was created by God, while Smith argues that the Big Bang has no cause. The book consists of alternating chapters by Craig and Smith, with each chapter being either a criticism of a preceding chapter or being criticized by a subsequent chapter. Part One consists of Craig's arguments that the past is necessarily finite and that God created the Big Bang, and Smith's criticisms of these arguments. Part Two

presents Smith's arguments that Big Bang cosmology is inconsistent with theism and Craig's criticisms of Smith's argument. The authors' arguments are based on Einstein's theory of relativity, and there is also a discussion of Stephen Hawking's new quantum cosmology.

Challenges the dominant big bang theory of the origins of the universe, arguing that the universe has neither a beginning nor an end and that it has endured and evolved through an infinite period of time

Terms such as "expanding Universe", "big bang", and "initial singularity", are nowadays part of our common language. The idea that the Universe we observe today originated from an enormous explosion (big bang) is now well known and widely accepted, at all levels, in modern popular culture. But what happens to the Universe before the big bang? And would it make any sense at all to ask such a question? In fact, recent progress in theoretical physics, and in particular in String Theory, suggests answers to the above questions, providing us with mathematical tools able in principle to reconstruct the history of the Universe even for times before the big bang. In the emerging cosmological scenario the Universe, at the epoch of the big bang, instead of being a "new born baby" was actually a rather "aged" creature in the middle of its possibly infinitely enduring evolution. The aim of this book is to convey this picture in non-technical language

accessibile also to non-specialists. The author, himself a leading cosmologist, draws attention to ongoing and future observations that might reveal relics of an era before the big bang.

Provides compelling evidence that creation myths from the dawn of civilization correspond to cutting edge astronomical discoveries • Exposes the contradictions in current cosmological theory and offers a scientific basis for the ancient myths and esoteric lore that encode a theory of continuous creation • By the scientist who was the first to disprove the Big Bang theory on the basis of observational data Recent developments in theoretical physics, including systems theory and chaos theory, are challenging long-held mechanistic views of the universe. Many thinkers have speculated that the remnants of an ancient science survive today in mythology and esoteric lore, but until now the scientific basis for this belief has remained cloaked in mystery. Paul LaViolette reveals the remarkable parallels between the cutting edge of scientific thought and creation myths from the dawn of civilization. With a scientific sophistication rare among mythologists, LaViolette deciphers the forgotten cosmology of ancient lore in a groundbreaking scientific tour de force. In direct, nontechnical language, he shows how these myths encode a theory of cosmology in which matter is continually growing from seeds of order that emerge spontaneously from the

surrounding subquantum chaos. Exposing the contradictions that bedevil the big bang theory, LaViolette offers both the specialist and the general reader a controversial and highly stimulating critique of prevailing misconceptions about the seldom-questioned superiority of modern science over ancient cosmology. By restoring and reanimating this ancient scientific worldview, Genesis of the Cosmos leads us beyond the restrictive metaphors of modern science and into a new science for the 21st century.

Quantum theory is so shocking that Einstein could not bring himself to accept it. It is so important that it provides the fundamental underpinning of all modern sciences. Without it, we'd have no nuclear power or nuclear weapons, no TV, no computers, no science of molecular biology, no understanding of DNA, no genetic engineering. In Search of Schrodinger's Cat tells the complete story of quantum mechanics, a truth stranger than any fiction. John Gribbin takes us step by step into an ever more bizarre and fascinating place, requiring only that we approach it with an open mind. He introduces the scientists who developed quantum theory. He investigates the atom, radiation, time travel, the birth of the universe, superconductors and life itself. And in a world full of its own delights, mysteries and surprises, he searches for Schrodinger's Cat - a search for quantum reality - as he brings every reader to a clear understanding of the most important area of scientific study today - quantum physics. In Search of Schrodinger's Cat is a fascinating and delightful introduction to the strange world of the quantum - an essential element in understanding today's world.

Today we are blessed with two extraordinarily successful theories of physics. The first is Albert

Einstein's general theory of relativity, which describes the large-scale behaviour of matter in a curved spacetime. This theory is the basis for the standard model of big bang cosmology. The discovery of gravitational waves at the LIGO observatory in the US (and then Virgo, in Italy) is only the most recent of this theory's many triumphs. The second is quantum mechanics. This theory describes the properties and behaviour of matter and radiation at their smallest scales. It is the basis for the standard model of particle physics, which builds up all the visible constituents of the universe out of collections of quarks, electrons and force-carrying particles such as photons. The discovery of the Higgs boson at CERN in Geneva is only the most recent of this theory's many triumphs. But, while they are both highly successful, these two structures leave a lot of important questions unanswered. They are also based on two different interpretations of space and time, and are therefore fundamentally incompatible. We have two descriptions but, as far as we know, we've only ever had one universe. What we need is a quantum theory of gravity. Approaches to formulating such a theory have primarily followed two paths. One leads to String Theory, which has for long been fashionable, and about which much has been written. But String Theory has become mired in problems. In this book, Jim Baggott describes "the road less travelled": an approach which takes relativity as its starting point, and leads to a structure called Loop Quantum Gravity. Baggott tells the story through the careers and pioneering work of two of the theory's most prominent contributors, Lee Smolin and Carlo Rovelli. Combining clear discussions of both quantum theory and general relativity, this book offers one of the first efforts to explain the new quantum theory of space and time. Originally presented as the author's thesis (doctoral--University of Groningen). Includes bibliographical references: (p. [291]-316) and index.

Stephen Hawking, the Lucasian Professor of Mathematics at Cambridge University, has made important theoretical contributions to gravitational theory and has played a major role in the development of cosmology and black hole physics. Hawking's early work, partly in collaboration with Roger Penrose, showed the significance of spacetime singularities for the big bang and black holes. His later work has been concerned with a deeper understanding of these two issues. The work required extensive use of the two great intellectual achievements of the first half of the Twentieth Century: general relativity and quantum mechanics; and these are reflected in the reprinted articles. Hawking's key contributions on black hole radiation and the no-boundary condition on the origin of the universe are included. The present compilation of Stephen Hawking's most important work also includes an introduction by him, which guides the reader though the major highlights of the volume. This volume is thus an essentialitem in any library and will be an important reference source for those interested in theoretical physics and applied mathematics. It is an excellent thing to have so many of Professor Hawking's most important contributions to the theory of black holes and space-time singularities all collected together in one handy volume. I am very glad to have them". Roger Penrose (Oxford) "This was an excellent idea to put the best papers by Stephen Hawking together. Even his papers written many years ago remain extremely useful for those who study classical and quantum gravity. By watching the evolution of his ideas one can get a very clear picture of the development of quantum cosmology during thelast quarter of this century". Andrei Linde (Stanford) "This review could have been quite short: 'The book contains a selection of 21 of Stephen Hawking's most significant papers with an overview written by the author'. This w
A highly technical book describing a new Cosmology for the Beginning of the Universe as well

as diverse related topics such as Quantum Field Theory, Tachyons, Quantum Coordinates and Dimensions, Inflationary Cosmology, complex space-time, complex General Relativity, the dodecahedral shape of the universe and so on. The intended audience is cosmologists, physicists, mathematical physicists, mathematicians, and graduate students in those areas.

Bestselling author and acclaimed physicist Lawrence Krauss offers a paradigm-shifting view of how everything that exists came to be in the first place. “Where did the universe come from? What was there before it? What will the future bring? And finally, why is there something rather than nothing?” One of the few prominent scientists today to have crossed the chasm between science and popular culture, Krauss describes the staggeringly beautiful experimental observations and mind-bending new theories that demonstrate not only can something arise from nothing, something will always arise from nothing. With a new preface about the significance of the discovery of the Higgs particle, A Universe from Nothing uses Krauss’s characteristic wry humor and wonderfully clear explanations to take us back to the beginning of the beginning, presenting the most recent evidence for how our universe evolved—and the implications for how it’s going to end. Provocative, challenging, and delightfully readable, this is a game-changing look at the most basic underpinning of existence and a powerful antidote to outmoded philosophical, religious, and scientific thinking.

Traces how the author, a physics professor, used the new science of loop quantum gravity to create a simple model of the universe that launched loop quantum cosmology, proposing the theory that the universe undergoes an infinite series of expansions and contractions through time.

Although everyone is familiar with the concept of time in everyday life and has probably given

thought to the question of how time began, recent scientific developments in this field have not been accessible in a simple understandable form. This book is important as it presents to readers current ideas about the role of time in theoretical cosmology.Recent observational discoveries, especially that the expansion rate of the universe is accelerating, have revolutionized the understanding of the energy content of the universe. This development leads to new possibilities for the beginning and end of cosmological time. This book emphasizes the notion of entropy and describes how it is theoretically possible that the universe may end in a finite time or that time can cycle and never end.Provided here is twenty-first century scientific knowledge, written by one of the world"s most eminent theoretical physicists, that will better enable the public to discuss further the fascinating idea of time. It is ideally suited also for young people considering a career in scientific research.

From Nobel prize-winner Roger Penrose, this groundbreaking book is for anyone "who is interested in the world, how it works, and how it got here" (New York Journal of Books). Penrose presents a new perspective on three of cosmology’s essential questions: What came before the Big Bang? What is the source of order in our universe? And what cosmic future awaits us? He shows how the expected fate of our ever-accelerating and expanding universe—heat death or ultimate entropy—can actually be reinterpreted as the conditions that will begin a new “Big Bang.” He details the basic principles beneath our universe, explaining various standard and non-standard cosmological models, the fundamental role of

the cosmic microwave background, the paramount significance of black holes, and other basic building blocks of contemporary physics. Intellectually thrilling and widely accessible, Cycles of Time is a welcome new contribution to our understanding of the universe from one of our greatest mathematicians and thinkers.

Presents the observations that helped establish our theories of the cosmos, from a unique and engaging perspective.

Cosmology is the study of the origin, size, and evolution of the entire universe. Every culture has developed a cosmology, whether it be based on religious, philosophical, or scientific principles. In this book, the evolution of the scientific understanding of the Universe in Western tradition is traced from the early Greek philosophers to the most modern 21st century view. After a brief introduction to the concept of the scientific method, the first part of the book describes the way in which detailed observations of the Universe, first with the naked eye and later with increasingly complex modern instruments, ultimately led to the development of the "Big Bang" theory. The second part of the book traces the evolution of the Big Bang including the very recent observation that the expansion of the Universe is itself accelerating with time.

#1 NEW YORK TIMES BESTSELLER When and how did the universe begin?

Why are we here? What is the nature of reality? Is the apparent “grand design” of our universe evidence of a benevolent creator who set things in motion—or does science offer another explanation? In this startling and lavishly illustrated book, Stephen Hawking and Leonard Mlodinow present the most recent scientific thinking about these and other abiding mysteries of the universe, in nontechnical language marked by brilliance and simplicity. According to quantum theory, the cosmos does not have just a single existence or history. The authors explain that we ourselves are the product of quantum fluctuations in the early universe, and show how quantum theory predicts the “multiverse”—the idea that ours is just one of many universes that appeared spontaneously out of nothing, each with different laws of nature. They conclude with a riveting assessment of M-theory, an explanation of the laws governing our universe that is currently the only viable candidate for a “theory of everything”: the unified theory that Einstein was looking for, which, if confirmed, would represent the ultimate triumph of human reason.

This book describes a new area of physics: the metatheory of physics theories. It develops a mathematical description of the nature of physics theories which it applies to the Theory of Everything or the Final Theory. It also develops quantum Turing machine and Quantum Computer formulations of the Standard Model of

Elementary Particles and SuperString Theories.

Two philosophers take opposing viewpoints to debate the fundamental question of whether the Big Bang was created by God or whether it occurred according to scientific theory.

For several decades since its inception, Einstein's general theory of relativity stood somewhat aloof from the rest of physics. Paradoxically, the attributes which normally boost a physical theory - namely, its perfection as a theoreti cal framework and the extraordinary intellectual achievement underlying i- prevented the general theory from being assimilated in the mainstream of physics. It was as if theoreticians hesitated to tamper with something that is manifestly so beautiful. Happily, two developments in the 1970s have narrowed the gap. In 1974 Stephen Hawking arrived at the remarkable result that black holes radiate after all. And in the second half of the decade, particle physicists discovered that the only scenario for applying their grand unified theories was offered by the very early phase in the history of the Big Bang universe. In both cases, it was necessary to discuss the ideas of quantum field theory in the background of curved spacetime that is basic to general relativity. This is, however, only half the total story. If gravity is to be brought into the general fold of theoretical physics we have to know how to quantize it. To date this has proved a formidable task

although most physicists would agree that, as in the case of grand unified theories, quantum gravity will have applications to cosmology, in the very early stages of the Big Bang universe. In fact, the present picture of the Big Bang universe necessarily forces us to think of quantum cosmology.

From Brian Greene, one of the world's leading physicists and author of the Pulitzer Prize finalist The Elegant Universe, comes a grand tour of the universe that makes us look at reality in a completely different way. Space and time form the very fabric of the cosmos. Yet they remain among the most mysterious of concepts. Is space an entity? Why does time have a direction? Could the universe exist without space and time? Can we travel to the past? Greene has set himself a daunting task: to explain non-intuitive, mathematical concepts like String Theory, the Heisenberg Uncertainty Principle, and Inflationary Cosmology with analogies drawn from common experience. From Newton's unchanging realm in which space and time are absolute, to Einstein's fluid conception of spacetime, to quantum mechanics' entangled arena where vastly distant objects can instantaneously coordinate their behavior, Greene takes us all, regardless of our scientific backgrounds, on an irresistible and revelatory journey to the new layers of reality that modern physics has discovered lying just beneath the surface of our everyday world.

Inflation and Quantum Cosmology discusses the inflationary universe scenario, including the problems of the standard big bang theory and the interplay between elementary-particle theory and cosmology. Inflationary universe models generate many different final perturbation spectra. For example, a model of an inflationary universe, through a casual mechanism, can predict energy density fluctuations leading to the formation of galaxies. The inflationary universe scenario makes possible simultaneous solutions to ten problems related to cosmology and elementary particle physics. One problem concerns the origin of density perturbations that show a picture of the large-scale structure of the universe. Some unexplored possibilities are related to isothermal perturbations generated during inflation or to adiabatic perturbations with a non-flat spectrum. An inflationary universe cosmology also includes stochastic inflation that describes the universe on very large scales—from fragmented mini-universes to another inflationary cosmos. The book also discusses the problem relating to the initial conditions from which an inflationary universe starts. This book is suitable for astronomers, astrophysicists, and professors of cosmology and cosmogenesis.
Leading scientists offer a collection of essays that furnish illuminating explanations of recent discoveries in modern astrophysics--from the Big Bang to black holes--the possibility of life on other worlds, and the emerging technologies that make such research possible, accompanied by incisive profiles of such key figures as Carl Sagan and Georges Lemaetre. Original.

Quantum gravity has developed into a fast-growing subject in physics and it is expected that probing the high-energy and high-curvature regimes of gravitating systems will shed some light on how to eventually achieve an ultraviolet complete quantum theory of gravity. Such a theory would provide the much needed information about fundamental problems of classical gravity, such as the initial big-bang singularity, the cosmological constant problem, Planck scale physics and the early-time inflationary evolution of our Universe. While in the first part of this book concepts of quantum gravity are introduced and approached from different angles, the second part discusses these theories in connection with cosmological models and observations, thereby exploring which types of signatures of modern and mathematically rigorous frameworks can be detected by experiments. The third and final part briefly reviews the observational status of dark matter and dark energy, and introduces alternative cosmological models. Edited and authored by leading researchers in the field and cast into the form of a multi-author textbook at postgraduate level, this volume will be of benefit to all postgraduate students and newcomers from neighboring disciplines wishing to find a comprehensive guide for their future research.

Consequences of quantum gravity on grander scales are expected to be enormous: only such a theory can show how black holes really behave and where our universe came from. Applications of loop quantum gravity to cosmology have especially by now shed much light on cosmic evolution of a universe in a fundamental, microscopic

description. Modern techniques are explained in this book which demonstrate how the universe could have come from a non-singular phase before the big bang, how equations for the evolution of structure can be derived, but also what fundamental limitations remain to our knowledge of the universe before the big bang. The following topics will be covered in this book: Hamiltonian cosmology: a general basic treatment of isotropy, perturbations and their role for observations; useful in general cosmology. Effective equations: an efficient way to evaluate equations of quantum gravity, which is also useful in other areas of physics where quantum theory is involved. Loop quantization: a new formalism for the atomic picture of space-time; usually presented at a sophisticated mathematical level, but evaluated here from an intuitive physical side. The book will start with physical motivations, rather than mathematical developments which is more common in other expositions of this field. All the required mathematical methods will be presented, but will not distract the reader from seeing the underlying physics. Simple but representative models will be presented first to show the basic features, which are then used to work upwards to a general description of quantum gravity and its applications in cosmology. This will make the book accessible to a more general physics readership.

This book is a simple, non-technical introduction to cosmology, explaining what it is and what cosmologists do. Peter Coles discusses the history of the subject, the development of the Big Bang theory, and more speculative modern issues like quantum

cosmology, superstrings, and dark matter. ABOUT THE SERIES: The Very Short Introductions series from Oxford University Press contains hundreds of titles in almost every subject area. These pocket-sized books are the perfect way to get ahead in a new subject quickly. Our expert authors combine facts, analysis, perspective, new ideas, and enthusiasm to make interesting and challenging topics highly readable.

In Search of Schrodinger's CatQuantum Physics And RealityBantam

Two world-renowned scientists present an audacious new vision of the cosmos that "steals the thunder from the Big Bang theory." —Wall Street Journal The Big Bang theory—widely regarded as the leading explanation for the origin of the universe—posits that space and time sprang into being about 14 billion years ago in a hot, expanding fireball of nearly infinite density. Over the last three decades the theory has been repeatedly revised to address such issues as how galaxies and stars first formed and why the expansion of the universe is speeding up today. Furthermore, an explanation has yet to be found for what caused the Big Bang in the first place. In Endless Universe, Paul J. Steinhardt and Neil Turok, both distinguished theoretical physicists, present a bold new cosmology. Steinhardt and Turok "contend that what we think of as the moment of creation was simply part of an infinite cycle of titanic collisions between our universe and a parallel world" (Discover). They recount the remarkable developments in astronomy, particle physics, and superstring theory that form the basis for their groundbreaking "Cyclic Universe" theory. According to this theory, the Big

Bang was not the beginning of time but the bridge to a past filled with endlessly repeating cycles of evolution, each accompanied by the creation of new matter and the formation of new galaxies, stars, and planets. Endless Universe provides answers to longstanding problems with the Big Bang model, while offering a provocative new view of both the past and the future of the cosmos. It is a “theory that could solve the cosmic mystery” (USA Today).

Creatio ex nihilo is a foundational doctrine in the Abrahamic faiths. It states that God created the world freely out of nothing - from no pre-existent matter, space or time. This teaching is central to classical accounts of divine action, free will, grace, theodicy, religious language, intercessory prayer and questions of divine temporality and, as such, the foundation of a scriptural God but also the transcendent Creator of all that is. This edited collection explores how we might now recover a place for this doctrine, and, with it, a consistent defence of the God of Abraham in philosophical, scientific and theological terms. The contributions span the religious traditions of Judaism, Christianity and Islam, and cover a wide range of sources, including historical, philosophical, scientific and theological. As such, the book develops these perspectives to reveal the relevance of this idea within the modern world.

"From the world-renowned physicist, co-founder of the World Science Festival, and best-selling author of The Elegant Universe comes this utterly captivating exploration of deep time and humanity's search for purpose. Brian Greene takes

readers on a breathtaking journey from the big bang to the end of time and invites us to ponder meaning in the face of this unimaginable expanse. He shows us how, from its original orderly state the universe has been moving inexorably toward chaos, and, still, remarkable structures have continually formed: the planets, stars, and galaxies that provide islands in a sea of disorder; biochemical mechanisms, including mutation and selection, animate life; neurons, information, and thought developed into complex consciousness which in turn gave rise to cultures and their timeless myths and creativity. And he describes, as well, how, in the deep reaches of the future, the nature of the universe will threaten the existence of matter itself. Through a series of nested stories Greene provides us with a clearer sense of how we came to be, a finer picture of where we are now, and a firmer understanding of where we are headed. Taken together, it is a completely new perspective on our place in the universe and on what it means to be human"--

Following a long-term international collaboration between leaders in cosmology and the philosophy of science, this volume addresses foundational questions at the limit of science across these disciplines, questions raised by observational and theoretical progress in modern cosmology. Space missions have mapped the Universe up to its early instants, opening up questions on what came before

the Big Bang, the nature of space and time, and the quantum origin of the Universe. As the foundational volume of an emerging academic discipline, experts from relevant fields lay out the fundamental problems of contemporary cosmology and explore the routes toward finding possible solutions. Written for graduates and researchers in physics and philosophy, particular efforts are made to inform academics from other fields, as well as the educated public, who wish to understand our modern vision of the Universe, related philosophical questions, and the significant impacts on scientific methodology.

For over three millennia, most people could understand the universe only in terms of myth, religion, and philosophy. Between 1920 and 1970, cosmology transformed into a branch of physics. With this remarkably rapid change came a theory that would finally lend empirical support to many long-held beliefs about the origins and development of the entire universe: the theory of the big bang. In this book, Helge Kragh presents the development of scientific cosmology for the first time as a historical event, one that embroiled many famous scientists in a controversy over the very notion of an evolving universe with a beginning in time. In rich detail he examines how the big-bang theory drew inspiration from and eventually triumphed over rival views, mainly the steady-state theory and its concept of a stationary universe of infinite age. In the 1920s, Alexander

Friedmann and Georges Lemaître showed that Einstein's general relativity equations possessed solutions for a universe expanding in time. Kragh follows the story from here, showing how the big-bang theory evolved, from Edwin Hubble's observation that most galaxies are receding from us, to the discovery of the cosmic microwave background radiation. Sir Fred Hoyle proposed instead the steady-state theory, a model of dynamic equilibrium involving the continuous creation of matter throughout the universe. Although today it is generally accepted that the universe started some ten billion years ago in a big bang, many readers may not fully realize that this standard view owed much of its formation to the steady-state theory. By exploring the similarities and tensions between the theories, Kragh provides the reader with indispensable background for understanding much of today's commentary about our universe.

BIG BANG THEORY IN TROUBLE. The big bang that is accepted as all but proven fact by the majority of cosmologists & other scientists, may be in serious trouble. Virtually every media article that relates to COSMOLOGY refers to a big bang that happened 10 to 15 billion years ago. Those articles occasionally mention technical difficulties concerning the BIG BANG, but invariably hasten to explain that those will soon be cleared up. Occasional articles appear that point out one or more of those flaws, but authors of those are invariably dismissed as

misguided "big bang bashers." This book marks the first significant attempt to gather & carefully examine BIG BANG PROBLEMS in a single document. Initial chapters introduce relativity, particle physics & quantum theory as related to current big bang COSMOLOGY. Standard theory, its many flaws, & serious questions regarding the "proofs" of big bang theory are then presented. The newer "inflationary" version of big bang theory is also discussed. All of which is done in a manner that is readily understandable by those having a general background in modern science. COSMIC SENSE BOOKS, P.O. Box 3472, Carson, NV 89702. Tel. (702) 884-3161.