The Bigger Bang

Societies through the ages have always been fascinated with our origins. In the last few years, scientists have begun to answer some of the most fundamental questions about the origin and early evolution of the universe. This book presents a fresh, engaging and highly readable introduction to these ideas.

Using novel, down-to-earth analogies, author James Lidsey steers us deftly on a journey to the cutting edge of cosmology. Step-by-step, we travel back in time through Lidsey's book until we arrive at the very origin of the universe. There we look at the fascinating ideas scientists are currently developing to explain what happened in the first billion, billion, billion, billionth of a second of the universe's existence – the 'inflationary' epoch. Along the way, we are given lucid accounts of many fascinating topics in theoretical cosmology, including the latest ideas on superstrings, parallel universes, and the ultimate fate of our universe. We also discover how the world of the very small (described by the physics of elementary particles) and the world of the very large (described by cosmology) are inextricably linked by events which wove them together in the first few moments of the universe's history.

Lucid analogies, clear and concise prose and straightforward language make this book a delight to read. It makes accessible to the general reader some of the most profound and complex ideas about the origin of our universe currently vexing the minds of the world's best scientists.

James E. Lidsey is a Royal Society University Research Fellow at Queen Mary and Westfield College, University of London. His research interests focus on the very early universe, especially inflation and the cosmological aspects of superstring theory. In 1998, he appeared in the *Sunday Times* "Hot 100" list of promising academics. For recreation, he is learning to play the mandolin, but with limited success to date.

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Cover illustration: Big Bang. Computer artwork depicting the Big Bang, the huge explosion that cosmologists believe created the Universe. The Big Bang occurred about 12 billion years ago, although the exact figure is uncertain. The Big Bang theory is based on the fact that the visible universe is still expanding outwards from a central point. Background micro-wave radiation, which is thought to be an after-glow of the explosion, has also been discovered.
Credit: Mehau Kulyk/Science Photo Library

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Preface

We live in a big universe. Even if we were able to travel across the universe at the speed of light, the journey would take us at least ten billion years. Why is the universe so large? Has the universe always been this big, or was it smaller in the past? If smaller, how small was it? Was there a time when the volume of the universe vanished?

We can ask related questions regarding matter in the universe. Why is the universe not empty? From where do the atoms that make up our bodies originate? When were these atoms created?

Questions such as these lead us inevitably to the origin of the universe. Did the universe have a definite beginning, or has it always existed? If it had a beginning, can we talk meaningfully about what might have happened beforehand? And what caused the universe to come into existence in the first place?

The purpose of this book is to address questions such as these. Moreover, because our own origin is linked with that of the universe as a whole, we are indirectly studying our own past when we investigate the beginning of the universe.

We will see that the structure of the universe is intimately related to the structure of the smallest elementary particles. This relationship between the world of the very large and that of the very small was manifest even during the first second of the universe's history. Remarkably, the conditions that prevailed when the universe was no more than

a fraction of a second old may have led to the formation of galaxies, stars and planets. Our existence billions of years later depends directly on what happened at that very early time.

Throughout this book we will encounter very large and very small numbers. The standard notation is to express such numbers as powers of ten. Thus one million (1,000,000) is ten to the power six because there are six zeros that follow the 1. It is written as 10^6. One billion (one thousand million), then, is written as 10^9. We will refer to one million million as one trillion and write it as 10^{12}. Very small numbers are written in a similar way. For example, one millionth is one divided by a million and is written as 10^{-6}. One billionth is denoted by 10^{-9}, and so on.

We will also encounter in this book references to a wide range of temperatures. Unless otherwise stated, we will measure temperature in degrees Celsius. The lowest temperature possible is -273.16°C, which is known as *absolute zero*. The temperature of outer space, for example, is about three degrees above absolute zero.

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