

new theories
of everything



JOHN D. BARROW

New Theories of Everything

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The Infinite Book

The Artful Universe Expanded

JOHN D. BARROW

New Theories of Everything

THE QUEST FOR ULTIMATE EXPLANATION

'I am very interested in
the Universe—I am specialising
in the Universe and all
that surrounds it'

— PETER COOK

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TO ROGER

Who still believes there should always be
something rather than nothing

Preface to the Second Edition

I was pleased to take the opportunity, provided by the Press, to prepare a new edition of *Theories of Everything*. Interest in this subject has continued unabated since my first attempts to explain their scope and limitations, and to place them in a broader cultural context than that of mathematical physics. Many new possibilities have emerged in the pursuit of a final string theory, and cosmology has taken an unexpected path into a realm populated by many other possible universes. Both developments have undermined the naïve expectations of many, that a Theory of Everything would uniquely and completely specify all the defining quantities of the Universe that make it a possible home for life. There is a long way to go before the physicists' Theory of Everything is formulated and decisively tested. In the meantime, I hope that this extended survey of the newest developments will help point readers in the right direction and illuminate the way.

John D. Barrow
Cambridge, February 2007

Preface to the First Edition

'Everything' is a big subject. Yet modern scientists believe they have stumbled upon a key which unlocks the mathematical secret at the heart of the Universe: a discovery that points them towards a monumental 'Theory of Everything' which will unite all the laws of Nature into a single statement that reveals the inevitability of everything that was, is, and is to come in the physical world. Such dreams are not new; Einstein wasted the latter part of his life in a fruitless and isolated quest for just this Theory of Everything. But today such schemes are not to be found only on the desks of a few maverick thinkers and unconstrained speculators; they have entered the mainstream of theoretical physics and are worked upon by a growing population of the world's brightest young thinkers. This turn of events raises many deep questions. Can their quest really succeed? Can our understanding of the logic underlying physical reality be completed? Do we foresee a day when fundamental physics will be complete, leaving only the complex details latent within those laws to be unravelled? Is this truly the new frontier of abstract thought?

This book is an attempt to describe what the challenge facing Theories of Everything really is; to pick out those aspects of things which must be understood before we can have any right to claim that we understand them. We shall try to show that while Theories of Everything, as currently conceived, may well prove necessary if we are to understand the Universe around and within us, they are far from sufficient. We shall introduce the reader to those extra ingredients which we need to complete our understanding of what is, and in so doing we aim to display many new ideas and speculations which transcend traditional thinking about the scope and structure of scientific inquiry.

Numerous people have helped this book come to completion. The Senatus of the University of Glasgow invited the author to deliver a series of Gifford Lectures at the University of Glasgow in January of 1988 and this book elaborates upon the content of some of those lectures. I am particularly indebted to Neil Spurway for his gracious help with everything associated with those lectures. For advertent or inadvertent comments and discussions which have helped in the writing of this book I am grateful to David Bailin, Margaret Boden, Danko Bosanac, Gregory Chaitin, Paul Davies, Bernard d'Espagnat,

Jeffrey Friedman, Michael Green, Chris Isham, John Manger, Bill McCrea, Leon Mestel, John Polkinghorne, Aaron Sloman, John Maynard Smith, Neil Spurway, Euan Squires, René Thom, Frank Tipler, John Wheeler, Denys Wilkinson, Peter Williams, and Tom Willmore.

Writing a book can be a miserable business, not only for the author, but for all those in his immediate orbit. The most perceptive reflection upon this situation was one made by the late Sir Peter Medawar. It applies not only to the activities of authors, but to obsessives of many sorts: ‘... it is a proceeding that makes one rather inhuman, selfishly guarding every second of one’s time and becoming inattentive about personal relationships; one soon formed the opinion that anyone who used three words where two would have done was a bore of insufferable prolixity whose company must at all times be shunned. A danger sign that fellow-obsessionals will at once recognize is the tendency to regard the happiest moments of your life as those that occur when someone who has an appointment to see you is prevented from coming.’ Because of the danger of such distortions, family members require special thanks for their patience and forbearance in the face of frequent neglect. Elizabeth has supplied her constant support in innumerable ways; without it this work would never have begun. Finally, our children, David, Roger, and Louise, have shown a keen and unnerving interest in the progress of the manuscript without which the book would undoubtedly have been finished in half the time.

J.D.B.

Brighton, September 1990

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