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978-0-521-76225-0 - Information and the Nature of Reality: From Physics to Metaphysics
Edited by Paul Davies and Niels Henrik Gregersen

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Information and the Nature of Reality From Physics to Metaphysics

Many scientists regard mass and energy as the primary currency of nature. In recent years, however, the concept of information has gained importance.

In this book, eminent scientists, philosophers, and theologians chart various aspects of information, from quantum information to biological and digital information, in order to understand how nature works. Beginning with a historical treatment of the topic, the book also examines physical and biological approaches to information, and the philosophical, theological, and ethical implications.

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Information and the Nature of Reality

From Physics to Metaphysics

Edited by

PAUL DAVIES

Arizona State University

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To the memory of Arthur R. Peacocke (1924–2006)

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About the authors

PHILIP CLAYTON (PhD Yale, 1986) is Ingraham Professor of Theology, Claremont School of Theology, and Professor of Religion and Philosophy, Claremont Graduate University. His areas of research include science and religion, philosophical theology, constructive theology, and metaphysics. He is author of *God and Contemporary Science* (1998) and *Mind and Emergence* (2004) and he has more recently written *Adventures in the Spirit* (2008) and *In Quest of Freedom: The Emergence of Spirit in the Natural World* (2009). Among his influential edited books are *The Re-Emergence of Emergence* (2006, with Paul Davies) and *The Oxford Handbook of Religion and Science* (2006).

PAUL DAVIES (PhD London, 1970) has held university positions at Cambridge, London, Newcastle, Adelaide, and Sydney before joining Arizona State University as Professor and Director of Beyond: Center for Fundamental Concepts in Science. He has helped develop quantum field theory, and alongside his scientific work in cosmology and atomic astrophysics he has maintained interests in the origin of time asymmetry and astrobiology. He has written more than 25 books, both popular and specialist works, including *About Time* (1995), *The Fifth Miracle* (1998), *How to Build a Time Machine* (2002), *The Goldilocks Enigma* (2007) and *The Eerie Silence* (2010). He has received many awards, including the 2001 Kelvin Medal, the 2002 Faraday prize, and in 1995 the Templeton Prize.

TERRENCE W. DEACON (PhD Harvard, 1984) taught for many years at Harvard University and Boston University, until in 2002 he joined the Department of Anthropology and the Helen Wills

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Neuroscience Institute at University of California, Berkeley. In his many articles and book chapters, Deacon's research combines human evolutionary biology and neuroscience in the investigation of the evolution of human cognition. His acclaimed book, *The Symbolic Species: the Co-Evolution of Language and Brain*, was published in 1997, and has been translated into several languages. In 2007 he was awarded the Staley Prize by the School of American Research.

NIELS HENRIK GREGERSEN (PhD Copenhagen University, 1987) is Professor of Systematic Theology at Copenhagen University, and Co-Director of the Centre for Naturalism and Christian Semantics. His areas of research are contemporary theology and science and religion, with a special emphasis on the complexity sciences and current developments in evolutionary biology. He is author of four books and more than 150 scholarly articles. He has edited or co-edited 15 books on science and religion, including *Design and Disorder* (2001), *From Complexity to Life* (2003), and *The Gift of Grace* (2005).

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JESPER HOFFMEYER is Professor Emeritus in the Department of Molecular Biology, University of Copenhagen. Hoffmeyer did work in experimental biochemistry in the 1970s, but gradually turned his research interests towards questions of theoretical biology: since 1988 in biosemiotics. Recent publications

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include *A Legacy of Living Systems: Gregory Bateson as Precursor to Biosemiotics* (2008) (as editor) and his major work *Biosemiotics: An Examination into the Signs of Life and the Life of Signs* (2008).

BERND-OLAF KÜPPERS studied physics and mathematics at the universities of Bonn and Göttingen. From 1971 to 1993 he worked at the Max Planck Institute for Biophysical Chemistry in Göttingen. Since 1994 he has been Professor of Natural Philosophy at the Friedrich Schiller University of Jena, and since 2008 also Director of the Frege Centre for Structural Sciences. Books include *Molecular Theory of Evolution* (1985), *Information and the Origin of Life* (1990), *Natur als Organismus* (1992), *Nur Wissen kann Wissen beherrschen* (2008) and *Wissen statt Moral* (2010). He is a member of Germany's National Academy of Sciences and of the Academia Europaea, London.

SETH LLOYD received his BA in physics from Harvard, his MPhil in philosophy of science from Cambridge, and his PhD in physics from Rockefeller University under the supervision of Heinz Pagels. After working at Caltech and Los Alamos, he joined the faculty at MIT, where he is Professor of Quantum-Mechanical Engineering. His research focuses on how physical systems process information. Lloyd was the first person to develop a realizable model for quantum computation. He is the author of *Programming the Universe* (2006) and is currently the Director of the W. M. Keck Center for Extreme Quantum Information Theory at MIT.

ERNAN MCMULLIN is the O'Hara Professor Emeritus of Philosophy and Founder Director of the Program in History and Philosophy of Science at the Notre Dame University. As a philosopher of science he has written and lectured extensively on subjects ranging from the relationship between cosmology and theology to the impact of Darwinism on Western religious

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thought. Among the books he has written or edited are *The Concept of Matter* (1963), *Newton on Matter and Activity* (1978), *Construction and Constraint: The Shaping of Scientific Rationality* (1988), *The Philosophical Consequences of Quantum Theory* (with James Cushing, 1989), *The Church and Galileo* (2005).

ARTHUR R. PEACOCKE (1924–2006) was a biochemist and theologian from Oxford University. Having taught at Birmingham he returned to Oxford in 1959 as Professor of Physical Biochemistry. In this capacity he published more than 125 papers and three books. Later he resumed his theological interests, became ordained in 1971, and went to serve as Dean of Clare College, Cambridge University. In 1985 he became the founding director of the Ian Ramsey Centre, at Oxford. In 1992–1993 he gave the Gifford Lectures, published as *Theology for a Scientific Age* (1993). In a series of books, beginning with *Science and the Christian Experiment* (1971) and ending with *All That Is: A Naturalistic Faith for the Twenty-First Century* (2007), he laid the groundwork for a generation of younger scholars in the field of science and religion. In 2001 he was awarded the Templeton prize.

HOLMES ROLSTON, III is University Distinguished Professor and Professor of Philosophy Emeritus at Colorado State University. He has written eight books, including *Science and Religion: A Critical Survey* (most recent edition 2006), *Environmental Ethics* (1988), and *Three Big Bangs: Matter-Energy, Life, Mind* (2010). He gave the Gifford Lectures, University of Edinburgh, 1997–1998, published as *Genes, Genesis and God* (1999). He has lectured on all seven continents. He was named laureate for the Templeton Prize in Religion in 2003. A recent intellectual biography is *Saving Creation: Nature and Faith in the Life of Holmes Rolston III*, by Christopher J. Preston (2009).

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JOHN MAYNARD SMITH (1920–2004) was a geneticist and theoretical evolutionary biologist. In the late 1950s and early 1960s he did pioneering work on the genetics of aging in fruit flies, and wrote *The Theory of Evolution* (1958). As the Founding Dean of the School of Biological Sciences at the University of Sussex (1965–1985), his interests turned into theoretical problems of evolutionary biology, especially concerning the relation between mathematics and life. He formalized the Evolutionary Stable Strategy (EES), today a standard tool in game theory. His classic works in theoretical biology include *The Evolution of Sex* (1978), *Evolution and the Theory of Games* (1982), and *The Major Transitions in Evolution* (with E. Szatmáry, 1997).

HENRY STAPP is a theoretical physicist at the University of California's Lawrence Berkeley Laboratory, specializing in the conceptual and mathematical foundations of quantum theory, and in particular on the quantum aspects of the relationship between our streams of conscious experience and the physical processes occurring in our brains. He is author of two books on this subject: *Mind, Matter, and Quantum Mechanics* (1993) and *Mindful Universe: Quantum Mechanics and the Participating Observer* (2007).

KEITH WARD is Emeritus Regius Professor of Divinity at Oxford University, Professorial research fellow at Heathrop College, London, and Fellow of the British Academy. Laid out in more than 25 books, his work covers wide areas, from systematic and philosophical theology to comparative theology and science and religion. In 2008 he finished a five-volume series of comparative theology, comparing the great religious traditions on concepts of revelation, creation, human nature, and community. Also in the field of science and religion he has produced a number of influential books, including more recently *Pascal's Fire: Scientific Faith and Religious Understanding* (2006) and *The Big Questions in Science and Religion* (2008).

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MICHAEL WELKER held faculty positions at the universities in Tübingen and Münster before he was offered the Chair of Systematic Theology at Heidelberg in 1991. He has been Director of the University's Internationales Wissenschaftsforum and is currently the Director of the Research Center for International and Interdisciplinary Theology. His method is to work through Biblical traditions as well as through contemporary philosophical, sociological, and scientific theories to address questions of contemporary culture and religion. His influential works in theology include *Creation and Reality* (1999), *What Happens in Holy Communion?* (2000), and *God the Spirit* (2004). Contributions to science and religion include *The End of the World and the Ends of God* (2000) and *Faith in the Living God* (with John Polkinghorne, 2001).

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Acknowledgments

This book grew out of a symposium held in the Consistorial Hall of Copenhagen University on 17–19 August 2006 under the aegis of the John Templeton Foundation and the Copenhagen University Research Priority Area on Religion in the 21st Century. The aim of the conference was to explore fundamental concepts of matter and information in current physics, biology, philosophy and theology with respect to the question of ultimate reality.

We, the editors and co-chairs, arranged the symposium ‘God, Matter and Information. What is Ultimate?’ in close collaboration with Dr Mary Ann Meyers, the Director of the Humble Approach Initiative under the John Templeton Foundation. The Humble Approach supports cutting-edge interdisciplinary research, insofar as it remains sensitive to disciplinary nuances, while looking for theoretical linkages and connections. Such studies are especially needed in areas of research that are central to the sciences, pertinent for a contemporary metaphysics, and yet are difficult to conceptualize and present in overview.

We are grateful to Mary Ann Meyers for her ongoing enthusiasm and expertise, and to the John Templeton Foundation for sponsoring the symposium so generously. We also want to thank the Editorial Director of Cambridge University Press, Dr Simon Capelin, for his assistance and encouragement in the publication of this book, and the anonymous peer reviewers who supported it. Lindsay Barnes and Laura Clark of the Press have set the editorial standards for this volume and worked in close collaboration with graduate student Trine-Amalie Fog Christiansen at Copenhagen University, who worked as a research assistant on this book and time and again showed her analytical skills. We owe thanks to her, and to Mikkel Christoffersen for assisting in the last phase of the production and for preparing the index.

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With two exceptions, all papers grew out of the Copenhagen symposium. We asked Professor Philip Clayton to write a brief philosophical history of the concept of matter, with special emphasis on modernity, and we thank him for doing this so swiftly and well. We also wanted to include the programmatic article of the late evolutionary biologist John Maynard Smith, 'The Concept of Information in Biology' (*Philosophy of Science* 67(2), June 2000); we acknowledge the journal for giving us the permission to reprint this article as Chapter 7 of this volume.

This volume is dedicated to the memory of Arthur Peacocke who, sadly, died on 21 October 2006. Arthur Peacocke was part of the group, but because of his illness he could not attend the conference, so his paper was discussed in his absence. Chapter 12 in this volume is one of the last works from his hand. Peacocke's research in biochemistry and in the intersection of theology and science is highly regarded, and his intellectual testimony can be found in his posthumous *All That Is: A Naturalistic Faith for the 21st Century* (Fortress Press, 2007). But for many of us, Arthur was not just a great scholar, but a mentor, a fellow-inquirer, and a friend who continued to listen, explore, and ask for more. We are indeed indebted to Arthur for his personal combination of rigour and generosity.