Science in the Looking Glass

What Do Scientists Really *Know?*

E. Brian Davies

Department of Mathematics
King's College London

OXFORD
UNIVERSITY PRESS

OXFORD
UNIVERSITY PRESS

Great Clarendon Street, Oxford OX2 6DP

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
and education by publishing worldwide in

Oxford New York

Auckland Bangkok Buenos Aires Cape Town Chennai
Dar es Salaam Delhi Hong Kong Istanbul Karachi Kolkata
Kuala Lumpur Madrid Melbourne Mexico City Mumbai Nairobi
São Paulo Shanghai Taipei Tokyo Toronto

Oxford is a registered trade mark of Oxford University Press
in the UK and in certain other countries

Published in the United States
by Oxford University Press Inc., New York

First published 2003

A catalogue record for this title is available from the British Library

Library of Congress Cataloging in Publication Data

(Data available)

ISBN 0 19 852543 5

10 9 8 7 6 5 4 3 2 1

Typeset by Newgen Imaging Systems (P) Ltd., Chennai, India
Printed in Great Britain
on acid-free paper by
Biddles Ltd, www.biddles.co.uk

Preface

Almost every month some book or television programme describes exciting developments in cosmology or fundamental physics. Many tell us that we are on the verge of finding the explanation for the Big Bang or the ultimate Theory of Everything. These will explain all physics in one fundamental set of mathematical equations. It is easy to be swept along by the obvious enthusiasm of the participants, particularly when they are making real progress in pushing back the boundaries of knowledge. Unfortunately, most of their brilliant new ideas are doomed to be forgotten, if only because they cannot all be right.

Consider the currently fashionable idea that our universe is just one of many unobservable, parallel universes, all equally real. How can one hope to describe the inner structures of such universes, each with its own values of the 'fundamental' constants? Many may be dull and featureless, but others are presumably as fascinating and complex as our own. However much some physicists declare the reality of these other universes, in practice their main function is to support the mathematical models of the day, or to 'explain' certain properties of our own universe.

My goal in this book is not to adjudicate on the correctness of such new and speculative theories. We will instead consider the development of science in a historical context, in order to find out how such questions have been resolved in the past, and to explain why many long established 'facts' have turned out not to be so certain. My conclusion is surprising, particularly coming from a mathematician. In spite of the fact that highly mathematical theories often provide very accurate predictions, we should not, on that account, think that such theories are true or that Nature is governed by mathematics. In fact the scientific theories most likely to be around in a thousand years' time are those which are the *least* mathematical—for example evolution, plate tectonics, and the existence of atoms.

The entire book is effectively an extended defence of the above statements. In the course of the discussion I risk the displeasure of many of my colleagues by explaining the feebleness of mathematical Platonism as a philosophy. I also provide psychological and historical support for the claim that mathematics is a human creation. Its success in explaining nature is a result of the fact that we developed much of it for precisely that purpose. Even the numbers which we use in counting become no more than formal symbols, invented by us, as soon as they are as big as 10^{1000} (1 followed by a thousand zeros). Pretending that we can count from 1 up to such a number 'in principle' is a fantasy, and will always remain so. Moreover, it is not necessary to believe this in order to be interested in pure mathematics.

Whatever some over-enthusiastic physicists might claim, there is much which is beyond our grasp, and which will probably remain so. Subjective (first person) consciousness is one such issue. Understanding the true nature of quantum particles is another, in spite of the proven success of the mathematical aspects of quantum theory. Contingency, or historical accident, has obviously had a major influence on geology and biology, but some physicists think that it is even involved in the form of the laws of physics. Whether or not this is true, scientists are right to believe that, with enough effort, they can push the boundaries of their subjects far beyond their present limits.

An unusual feature of the book is that I try to explain why philosophical issues are important in science by means of simple examples. This is not the style followed by academic philosophers, but it makes the issues easier to understand, particularly in a popular context. In addition, discussions about the status of money, zombies, or rainbows are more fun than dry logical arguments about ontology.

I am painfully aware that the scope of the book is far wider than anybody's expertise could span in this age of specialists. The attempt is worth making, because arguments informed by only one branch of science are inevitably distorted by that fact. I do not claim to have found the final answer to all of the deep questions in the philosophy of science, but hope that readers who have not previously thought much about these will see why they are important.

People vary enormously in their liking of mathematics. Many switch off as soon as they see it, and editors of popular books advise their authors to reduce it to the absolute minimum. I have gone as far as I can in this direction, and reassure the allergic reader that any difficult passages can be skimmed over. They are present to ensure that interested readers do not feel cheated by being told conclusions without any evidence in their support.

I wish to acknowledge invaluable advice, or sometimes just stimulation, which I have received from many friends and colleagues, in particular Martin Berry, Alan Cook, Richard Davies, Donald Gillies, Nicholas Green, Andreas Hinz, Hubert Kalf, Mike Lambrou, Peter Palmer, Roger Penrose, David Robinson, Peter Saunders, Ray Streater, John Taylor and Phil Whitfield. I do not, however, burden them with the responsibility of agreeing with anything I say here. I also thank my family for providing an atmosphere in which a task such as this could be contemplated; I know that the time which I have devoted to it has put me in great debt to them.

Contents