

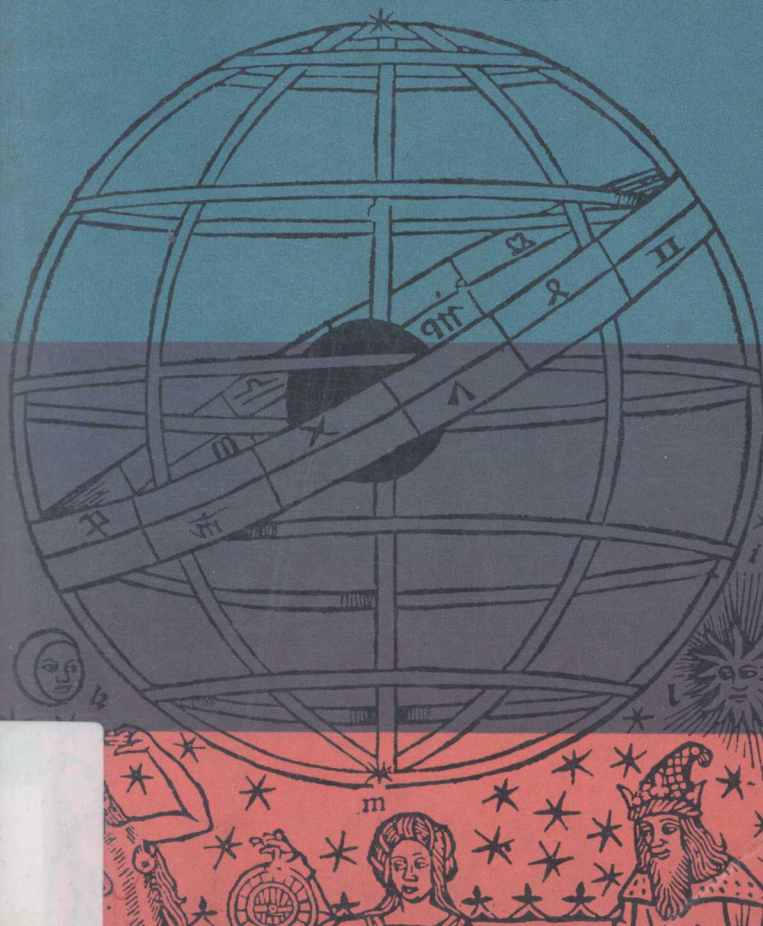


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The Fabric of the Heavens

Stephen Toulmin and
June Goodfield





Dr Stephen Toulmin, who is married to June Goodfield, was born in London in 1922 and educated at Oundle School and King's College, Cambridge, where he read physics. After wartime research work in radar he took his Ph.D. and became a university lecturer at Oxford, later being appointed at a very early age as Professor of Philosophy at Leeds University. His long-standing interest in the relevance of science, in its wider aspects, to our ideas led him to set up in London a new Unit for the History of Ideas for the Nuffield Foundation in order to produce books and films. Associate Secretary of the International Society for the History of Ideas, he has contributed many articles to newspapers and learned journals, and his books include *The Philosophy of Science* (1953).

June Goodfield was born at Stratford-on-Avon in 1927 and attended University College, Nottingham, where she took an honours degree in zoology, before going on to post-graduate research at Oxford. Later she taught at Cheltenham Ladies' College, where she made a documentary film of the college, and at Benenden School. After a period as lecturer at Leeds University she is now writing and directing a series of films for the new Unit for the History of Ideas. She recently directed a film in the U.S.A. for the National Film Foundation. Doctor and Mrs Toulmin live in London.

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THE FABRIC OF THE HEAVENS

STEPHEN TOULMIN AND

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THE FABRIC OF THE HEAVENS

STEPHEN TOULMIN
JUNE GOODFIELD



with sixteen plates



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When I have heard small talk about great men
I climb to bed; light my two candles; then
Consider what was said: and put aside
What Such-a-one remarked and Someone-else replied.

They have spoken lightly of my deathless friends
(Lamps for my gloom, hands guiding where I stumble),
Quoting, for shallow conversational ends,
What Shelley shrilled, what Blake once wildly muttered. . . .

How can they use such names and be not humble?
I have sat silent; angry at what they uttered.
The dead bequeathed them life; the dead have said
What these can only memorize and mumble.
Grandeur of Ghosts, Siegfried Sassoon

‘. . . the rest
From man or angel the great Architect
Did wisely to conceal and not divulge
His secrets to be scann’d by them who ought
Rather admire; or, if they list to try
Conjecture, he his fabric of the heavens
Hath left to their disputes, perhaps to move
His laughter at their quaint opinions wide
Hereafter; when they come to model heaven
And calculate the stars, how they will wield
The mighty frame; how build, unbuild, contrive
To save appearances; how gird the sphere
With centric and eccentric scribbled o’er,
Cycle and epicycle, orb in orb.’

Paradise Lost, Book VIII, John Milton

AUTHORS' FOREWORD

THOSE who rightly regret the contemporary division of educated men into 'two cultures' – or, at any rate, into two separate circles of conversationalists – can take comfort from one thing: namely, that we do still all grow up sharing a common conception of the world we live in, at any rate so far as concerns the main outlines of its structure and the chief phases of its development. This 'commonsense' view of the world, therefore, represents common ground shared by the two cultures, and any study of the process by which it came to its present form, and of its credentials, can hope to strike a chord in the minds of 'scientists' and 'humanists' alike. It was in this conviction that we started in 1957 at Leeds University a teaching course on *Origins of Modern Science*, which was followed with growing interest and equal success by students from both the Arts and Science Faculties; and we remain convinced that the evolution of scientific ideas – in particular, the embryology of our commonsense view of the world – is an important part of the region where scientific, historical, and literary studies overlap. On this common ground we may hope to restore the conversations between the two cultures which in earlier generations were taken for granted.

The present book is the first of four volumes, which will together form a connected series on *The Ancestry of Science*. The first three volumes comprise extended case-studies, centred on particular groups of topics which have played important parts in the evolution of our ideas. Here, in *The Fabric of the Heavens*, we shall be looking at the development of astronomy and dynamics, and the contribution these sciences have made to our cosmological picture. The

AUTHORS' FOREWORD

second volume, on *The Architecture of Matter*, will concentrate on conceptions of material substance, both in physiology and in chemistry, and the gradual clarification of ideas about the special character of living things. The third volume will be a study of the way in which the historical dimension entered science: how the earlier, unhistorical vision of a static Nature was displaced by a developing one, and how this new historical approach has begun to spread from geology and zoology (where it bore its first fruit) into the physical sciences. In the final volume, we shall use the material gathered together in the earlier volumes in order to analyse the changing relations throughout history between science, literature, philosophy, technology, religion, and other aspects of human life.

Anyone who embarks on a work of historical synthesis and interpretation, such as this, inevitably places himself much in the debt of the scholars by whose devoted work he profits. In the present case, this debt is doubly worth acknowledging: for, during the last fifty years, the historical development of the natural sciences has been studied with a new care and disinterestedness, and all this work has begun to lead – especially since 1946 – to an exciting new picture of the subject. Since little of this new picture has yet found a way into general literature, which tends rather to carry over into a more critical age the polemical prejudices of the nineteenth century, we have tried here to make the best use we could of the results of present-day scholarship. Our principal debts we have acknowledged in the reading-lists at the end of each chapter: however, we must include here a general expression of gratitude to all those whose work has led during the last few years to a better understanding of the scientific conceptions of our predecessors. Our gravest problem has been that of selection: in this, we have chosen to concentrate on a limited number of representative figures and to expound their views at some length, rather than make any pretence of being exhaustive.

'If you begin by treating the scientific ideas of earlier cen-

AUTHORS' FOREWORD

turies as myths, you will end by treating your own scientific ideas as dogmas': we have tried, throughout this book, to display the developing character of the scientific endeavour, and to indicate why the different problems of cosmology came to be tackled in the order in which they did. If we are to understand even our own scientific ideas, and do more than simply manipulate with the most up-to-date calculi, we shall do well to study the strong points of the scientific systems which they displaced. From the quandaries and difficulties which delayed the formation of our modern 'common sense' we can discover best the true character and meaning of our twentieth-century conceptions.

STEPHEN TOULMIN

London 1960

JUNE GOODFIELD

With the publication of this Pelican edition we have taken the opportunity to make a number of revisions in the text, and we are most grateful to all those who brought these to our notice.

S.T.

J.G.

GENERAL INTRODUCTION: COSMOLOGY

THE task of these books is to illustrate and document the manner in which our chief scientific ideas have been formed. We shall begin with two sciences whose development has been very closely linked: astronomy and dynamics. These two sciences have tried to answer such questions as: What are the things one can see in the sky? How do they move? What makes them move? Are they at all like the things on the earth around us, and do they move in the same way? About all these things, twentieth-century common sense has come to take the scientist's answers for granted, and our task is to follow out the sequence of steps by which our modern view was reached. How did the world look (we must ask) to the men who first tried to make sense of the things that happen in the sky above us? What conception did they have of the sun and moon, the stars and planets; and what problems had to be solved before we can recognize their point of view as our own, and say – as one does at the cinema – 'This is where we came in'?

Common sense is a powerful mould. If we are to see the world through the eyes of the first astronomers, we must deliberately lay aside many beliefs and distinctions which nowadays we accept quite unthinkingly. For at the outset men faced the sky (as they did all aspects of nature) in a state of far greater ignorance than we can easily imagine. They were confronted not by unanswered questions but by problems as yet unformulated – by objects and happenings which had not yet been set in order, far less understood. (When you were a child, what would you yourself have made of the heavens, with no adults to guide your eyes and

thoughts?) To understand fully the scientific traditions which we have inherited, it is not enough to discover what our predecessors believed and leave it at that: we must try to see the world through their untutored eyes, recognize the problems which faced them, and so find out for ourselves why it was that their ideas were so different from our own.

What is required? Not just demoting beliefs which we now regard as established facts to the rank of daring speculations. Different situations gave rise in earlier times to different practical demands; different practical demands posed different intellectual problems; and the solution of these problems called for systems of ideas which in some respects are not even comparable with our own. Consider, for example, the question, How do the earth and the sun move relatively to one another? We are satisfied nowadays that the earth goes round the sun. We regard this as an established fact; though it was (and is) surely not *obvious*. What, then, could the first astronomers say about this? And what should we say about it ourselves, had we not grown up taking so much in the way of astronomical ideas for granted?

The correct answer is – that we should not even have understood the question. To lay aside our belief that the earth goes round the sun (our heliocentric *theory* of the planetary system) is to remove only the top layer of our astronomical garments. The men who first began to ask questions about the sky did not put forward a rival, geocentric theory, or indeed any theory at all – and why should they? Such questions as whether the earth goes round the sun or vice versa are comparatively sophisticated ones. The problems the first astronomers were concerned with were of a kind which did not give rise to theoretical questions, and it is a failure of our understanding if we discuss their ideas as though they were committed to some theory – for instance, the geocentric theory. If anything, it was their whole *attitude*, and the whole range of practical problems they