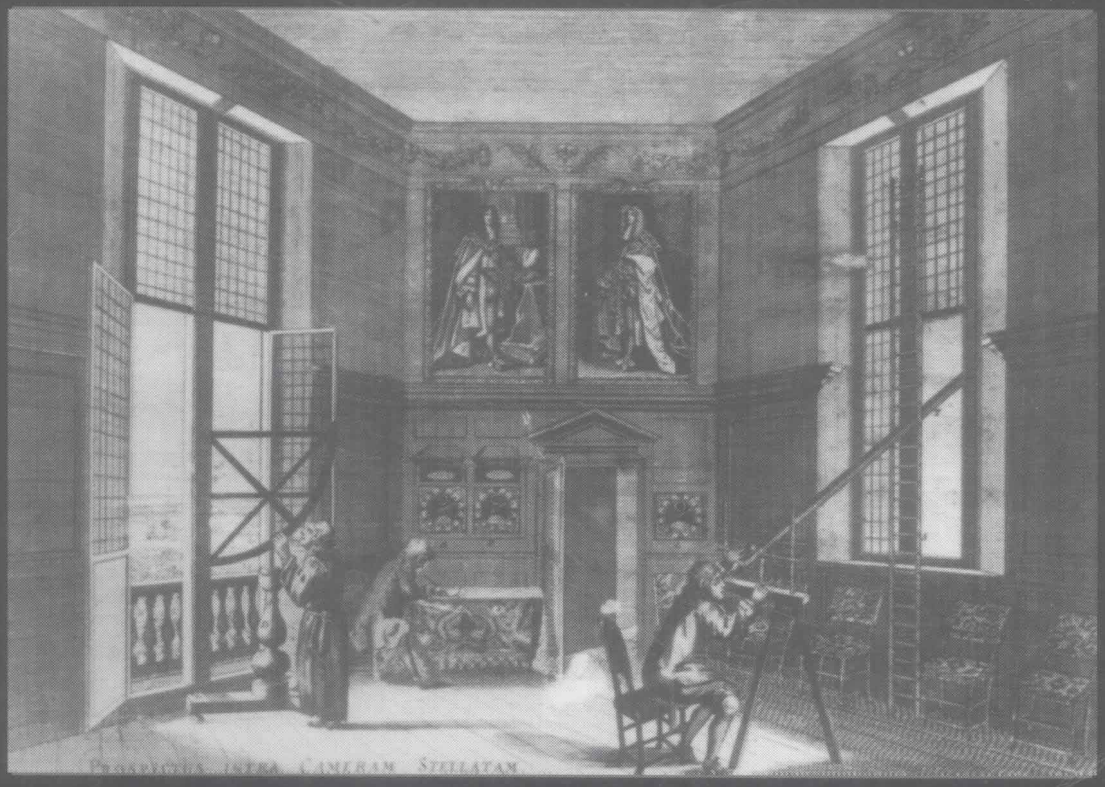
Glimpses of Reality

Episodes in the History of Science



Byron Wall

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Episodes in the History of Science

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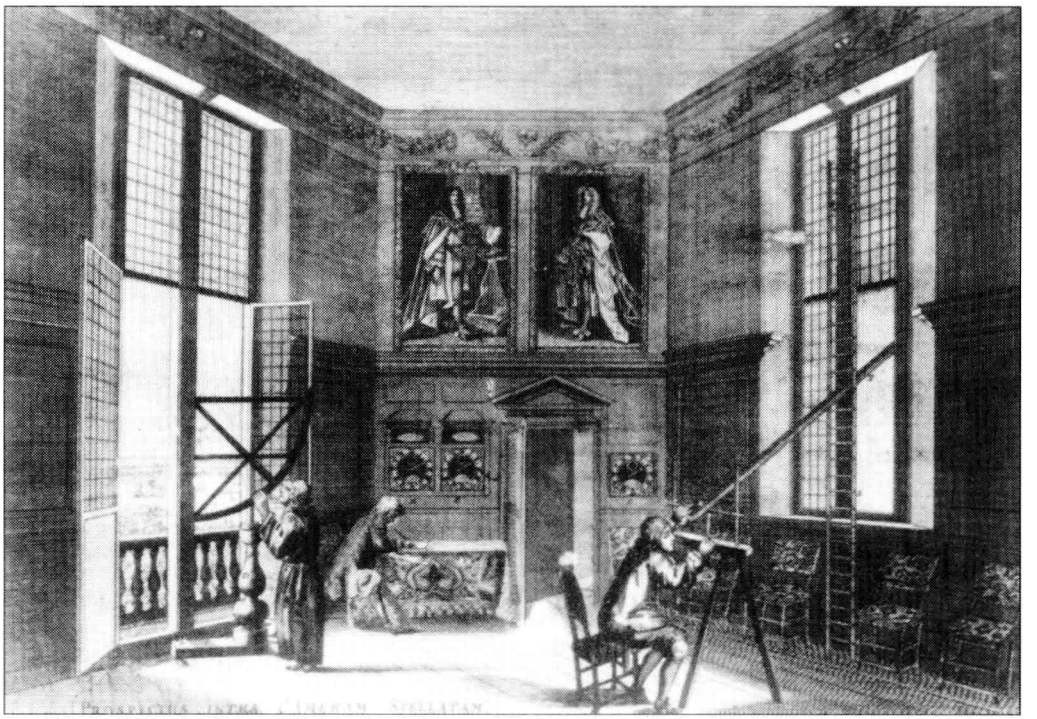

The Octagon Room of the Royal Observatory at Greenwich, designed by Christopher Wren and set up in 1675. From an etching by Francis Place.

PREFACE

As the title suggests, this book examines efforts made throughout the span of history to understand the natural world. This book is not comprehensive by any means. It is a selection of topics, all from the history of western science, and they are chosen as much as anything in order to make a coherent, connected story. Too often texts that survey the history of science try for completeness and end up being encyclopedias, valuable as reference works but mind numbing for those new to the subject matter.

It has been my particular goal to relate the chosen episodes in science to each other by showing how they treat the same topics, methods of study, and criteria for acceptance and rejection of explanations. I have particularly stressed the implied logic of explanatory models, beginning with the ancient philosophers and continuing throughout the book. There is much mention of Plato's "saving the phenomena," of the Ad Hoc hypothesis, of the syllogism *modus tollens*, of the mechanist model and the axiomatic system.

The intended audience for this book is a college/university class exploring the sweep of science. Such classes often satisfy a science distribution requirement for students whose interests are primarily in the humanities. Accordingly, I have avoided taking the language of science and mathematics for granted and instead have tried to explain concepts in words that might be more compactly expressed in formulas. On the other hand, I have not shied away from discussing mathematics and mathematical formulations since they are so important for understanding why certain concepts were valued more highly than others.

This text is a direct outgrowth of my classes at York University and I have written this book with my own students in mind. At York, this book will be used as one of the texts in a course that spans an entire academic year. It could be used alongside a more traditional survey text if a complete overview is desired or in combination with some other texts that explore some of these topics more deeply.

The text is divided into four parts: Part I examines the roots of scientific thinking in the ancient world, particularly ancient Greece. Part II looks at the Scientific Revolution

of the 16th and 17th centuries, concentrating on an examination of the major figures. Parts III and IV divide the subject matter of science since Newton. Part III follows developments in the physical sciences, mostly physics with a glance at 20th century astronomy. Part IV concerns the world of biology as it was transformed by the theory of evolution and by genetics.

Footnotes are provided for most direct quotations and a list of further readings is appended to each chapter, but no attempt is made to document every fact or assertion made. For the most part, the facts cited are well known and generally accepted by scholars in the field. I can be held responsible for any quirks of interpretation and emphasis, though most of the views I espouse have been expressed many times by others in the field. These are, after all, some of the major events in the history of science, about which much has been written. My hope for originality lies in the comparisons and analogies I try to make among these different developments, and if this book has any value it will be in helping others to see patterns in this evolution that make science make sense.

Though my name along appears on the title page, the production of this work has been a team effort involving long hours of editing my prolix and obfuscating prose by my wife Martha, followed by my son, Alex, putting the entire output, pictures, footnotes, and text into an attractive and legible layout. When we were not going about our separate tasks on this book, we were engaging in arguments about its content. All of this often in all night sessions. Any outright errors or incomprehensible statements that remain, however, are strictly my fault.

Byron E. Wall
Toronto
August 9, 2001

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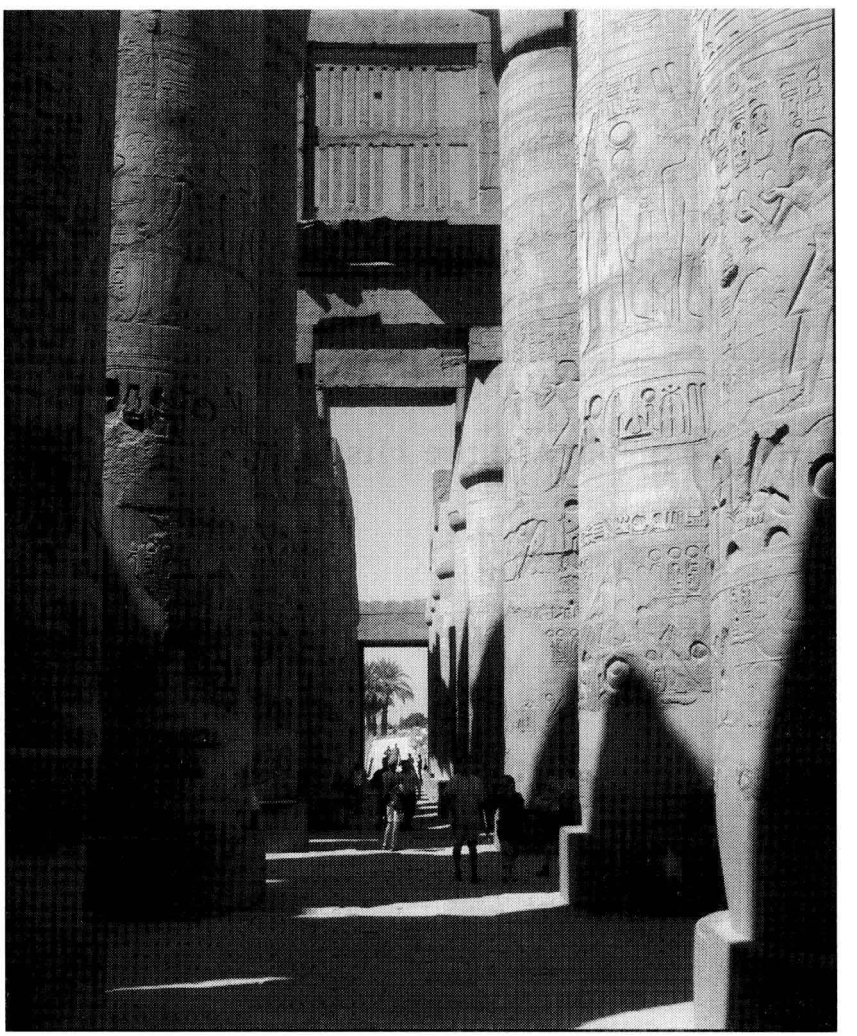

The Ancient Egyptian Temple of Karnak.

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PART ONE

Ancient Beginnings

Science in the form we recognize today emerged in the two-hundred-year period between 1500 and 1700 CE, now called the "Scientific Revolution." It did not spring out of nothing. Indeed most of the ideas that coalesced in the scientific revolution had been around for millennia.

The great ancient civilizations had an interest in nature and some very powerful tools for studying and analyzing it. Nature had to be objectified in order to begin to think about it systematically. Abstract thinking had to be developed in order to categorize and classify ideas. Speculative ideas about the material and form of the world had to be put forward for discussion and analysis. Logic and mathematics had to be developed in order to put different insights and observations into systems of ideas. And all the effort to do these things had to be seen to be worthwhile.

These steps were not taken all at once, nor did they follow each other in an orderly and predictable manner. The first stages of abstract thinking and the development of mathematical technique took place long before ideas began to be put forth about the general makeup of the world. Then in the relatively short space of only a few hundred years, almost all the basic questions that have concerned science ever since were asked and discussed. This amazing flowering did not happen all over the world, but instead was centered on just one ancient civilization, Greece. The Greeks took an objective interest in the world and scrutinized it to the best of their abilities.

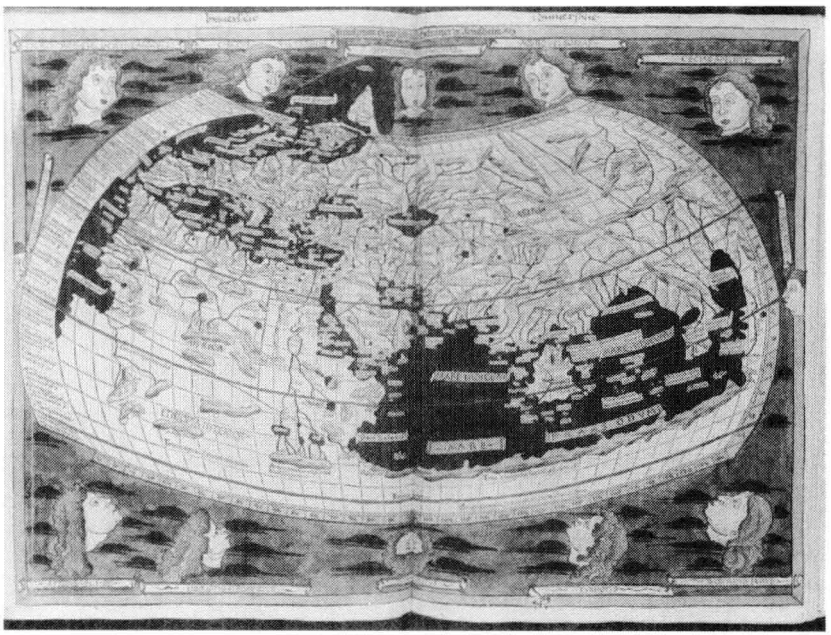
Then, just as abruptly, the push toward science ideas came to a halt and other preoccupations took their place in much of the world. During this long period those who were inter-

ested in understanding nature spent most of their time sifting through ideas already expressed hundreds of years before.

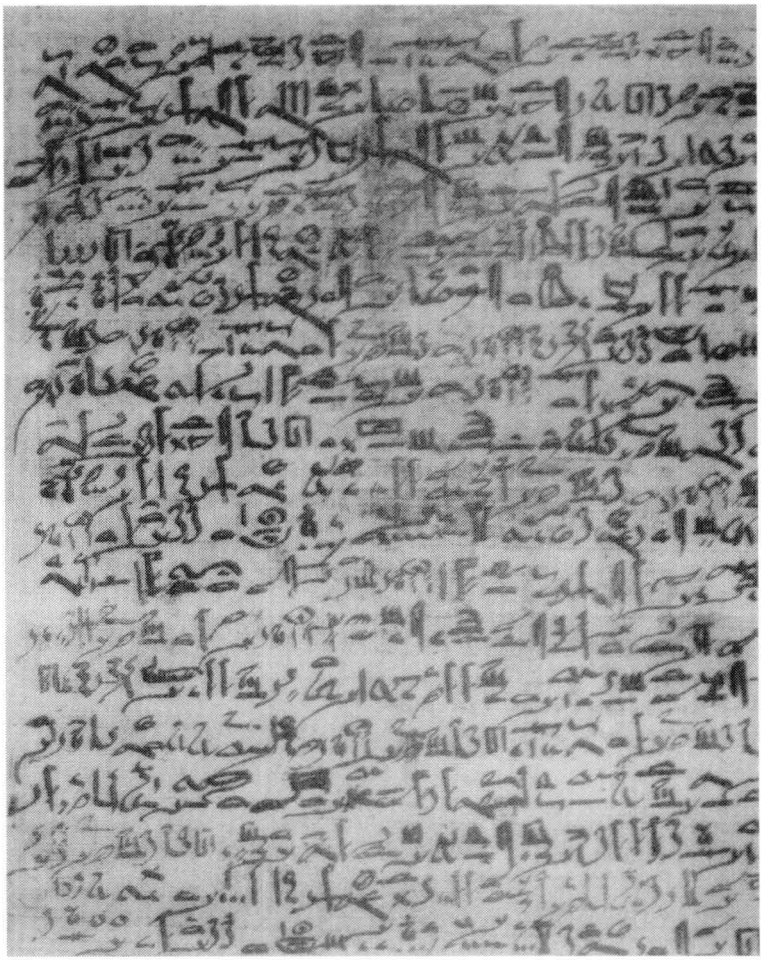
One of the problems that beset the ancient struggle to understand the world was premature success. After a few centuries of mulling over the major questions about the world, a number of standard answers emerged. These were very well-reasoned analyses based on available information. They were compelling. Unfortunately, one of the by-products of convincing answers is that people stop asking the questions. And unfortunately, as far as a scientific understanding of nature was concerned, the answers produced by the ancients were generally wrong.

Aristotle was the leading thinker of antiquity and Aristotle expressed himself convincingly on almost every subject imaginable. It took a very long time to get past Aristotle's view of the world and begin to examine it all anew. It is, of course, much more complicated than this. A vast amount of the more scientific writings of ancient times were lost for centuries and only found again when interest was rekindled during the Renaissance. As far as later Greek (Hellenistic) science is concerned, the existing works were preserved, translated, and studied extensively in the Arab world, where many lines of thought were extended in important ways. But the lively, open-ended questioning from first principles that was the hallmark of ancient Greece lay dormant for over a thousand years in the Middle Ages.

In the chapters that follow in Part One, some of those essential steps and essential questions will be reviewed: the first glimmerings of mathematical calculation; speculations about the general nature and material of the world; some attempts at grand syntheses and their pitfalls; the powerful influence of Plato and Aristotle; the triumphant emergence of reliable mathematics with Euclid; and the application of complex mathematics to solving the perceived problems of astronomy. These are only some of the vital steps taken in ancient times, but they are among the most important. Out of these issues, the Renaissance fashioned science.



A world map from the 15th century based upon Ptolemy's Geography from the 2nd century.



Egyptian Hieroglyphs.