Chapter 1

INTRODUCTION

Most people know, at least in some vague way, that the sophisticated technology that drives our society has been driven in turn by fundamental discoveries of physics. But, just what is physics? It derives its present name from the Greek word for nature; it was previously called natural philosophy. Physics can be defined as the science that deals with matter, energy, motion and force. It studies the fundamental building blocks of the universe and how they interact. It seeks answers to such fundamental questions as: What kind of world do we live in? How does it work? What are the fundamental laws of nature? Thus, physics is the basic science from which all others have derived.

Transistors, microchips, lasers, computers, telecommunications, nuclear power and space travel are among the many applications of physics that are so pervasive in our times. In our daily newspaper or weekly magazine, we often find articles that attempt to explain to a lay public a variety of topics related to physics. These might be sophisticated experiments on fundamental particles of matter; space probes and their missions; discoveries of astronomy in very remote regions of space; exotic new theories on the nature of matter, or the universe as a whole.

The relevance of physics is all around us. Although not as palpable as in the days of the Cold War with the Soviet Union, the terrifying threat of nuclear holocaust still hangs over all mankind. With so many programs competing for federal funds, government support of very expensive scientific ventures has become an issue of public interest. Except for fundamentalist groups, few, if any, religious leaders dare challenge the experimental findings of physics. No metaphysical speculation about the nature of reality[1], whether by lay people or professional philosophers, can ignore these findings. We clearly live in times that require at least some modest level of literacy in physics, one of the most profound achievements of the human mind. Unfortunately, physics is the least known and the most intimidating of all sciences. This is true even for many who are literate at some level about other human endeavors.

Among the factors that make physics appear so alien to so many people are the difficulty of many of its concepts, its pervasive use of advanced mathematics and cryptic symbolism, and the sophistication of its instruments, whose complexity goes far beyond the telescope first used by Galileo in 1609.

Although strongly intimidated by physics, much of the lay public has

[1] In this book, the terms world, universe and reality will be used interchangeably. The term "reality" derives from the Latin word "res" meaning thing. Thus, reality refers to the totality of all things.

been, and still is, intrigued by the fundamental nature of its inquiry. This is shown by the success of dozens of books that have been written since Stephen Hawking' s "A Brief History of Time" (1988) became a best seller.

In most of the popular books on the market, however, the bulk of the material is at a level of presentation and detail that goes beyond the background and interest of much of the general public. (A notable exception is Roger S. Jones' very readable "Physics for the Rest of Us", Contemporary Books, 1992). Many of these books focus on specific areas of scientific endeavor; some are offered as part of a series that covers a broader area of physics.

This book is devoted to a basic, non-mathematical presentation of physics to *motivated beginners*, that is, intelligent people who have no prior scientific or mathematical background, but are interested in learning something about this fundamental science. While many may not wish to go beyond this book, others could profitably use it as the first stepping stone to more advanced popular books.

Physicists undergo a long and demanding training in order to be able to do their work. It is far from hopeless, however, for a motivated beginner to acquire some general, conceptual understanding of many of physics' basic ideas and their philosophical significance.

In a concise, straightforward and reader-friendly style, the book presents an overview of physics in semi-historical sequence, enlivened here and there by biographical sketches of some of the major players. The semi-historical style makes possible a gradual presentation of new concepts, each supported by the necessary background. This style has also the advantage of giving some sense of how some of the greatest scientific discoveries gradually unfolded over the centuries. The book can then be seen as a brief history of the human quest for answers to the mysteries of the universe.

There is no way that a book on physics can be written to read like a novel. The motivated reader, however, may come to see the story of physics as an intriguing detective novel, in which a side detail of one day becomes a crucial clue to a later discovery.

A book that attempts to popularize a subject as complex as physics faces the obvious necessity of omitting all of the math and most of the material. Much more difficult is deciding where to dwell more deeply (without losing the reader) and where to go more lightly (without trivializing the material). Inevitably, from one section to another, what is too much for one reader will be not enough for another.

The book begins with ancient astronomy and the laws of motion, and then leads the reader through the essentials of energy, atoms, molecules,

particles in motion, waves, light, and electromagnetism (Chapters 2-9). These all serve as preliminaries to the two fundamental theories on which contemporary physics rests: relativity and quantum mechanics (Chapters 10-17). Chapter 18 gives a summary of the fundamental particles of matter and the forces by which they interact. Chapter 19, the last, gives a cosmic perspective based on the currently prevailing theories on the origin, evolution, structure and future of the universe as a whole.