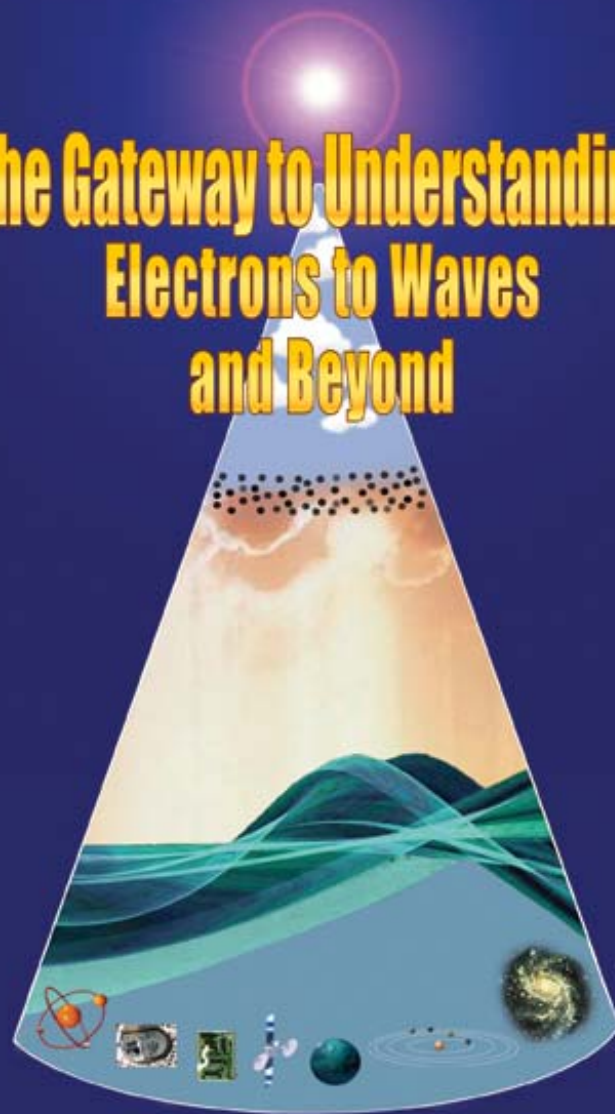


**The Gateway to Understanding:
Electrons to Waves
and Beyond**



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The Gateway to Understanding: Electrons to Waves and Beyond

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Cover Illustration: *The design on the cover shows the progression of concepts to application masses; a journey from the viewpoint, to postulates, to fine energy particles, leading to waves, down to its condensation to solid matter and eventually arriving at the final end point: the panoramic physical universe in all of its aspects, spanning from the microscopic to the macroscopic universe-- ranging in size from an atom, to a device, to a circuit, to a satellite, to the earth, to the solar system, to the Milky Way galaxy and beyond.*

*Dedicated to
the Pioneers and Founders
of Our Technical World,
Mavericks amongst Mortal Men,
Who Have Gifted Us with the
Vital Sciences.*

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Foreword

The study of electronic waves has been broken down into artificial subdivisions where most texts cover a small part of the subject mathematically while ignoring the rest. In our scientific community, there has been a need for a coherent, one-stop approach that covers the breadth of this material in a manner that allows a total comprehension of the subject. I believe this book finally fills this void by delivering this long-awaited material.

The field of electronic waves has not only had a profound impact on our scientific thinking and understanding of the universe around us, but has found numerous applications based on the mathematical sophistication of Maxwell's equations.

Most people in our highly automated society strive toward a meaningful understanding of the workings of electronic equipment and the major principles behind the fascinating form of energy called electricity and electronic waves. Most textbooks on the subject, however, ignore the basic concepts and introduce such a great deal of mathematical complexity that most students of science consider the subject of electricity untenable. Professor Radmanesh has written this book with the hope of inspiring and enlightening those individuals who desire an understanding of the world of electricity based on a top down approach with no undue complexity.

It will become obvious to the reader, as it has to me, that this book is the result of many years of observation and codification of the physical universe with particular attention to a deep understanding of electronic waves. In this work the origin of our universe is examined and many novel principles are freshly and elegantly introduced.

The book begins by examining the scientific fundamentals and presents a solid understanding of the material universe and its three original postulates leading to four constituent components, which have paved the way to its numerous applications (Chapters 1- 3).

Chapters 4 through 9 present a panoramic view of waves based on major discoveries that took the world of sciences by surprise when

they were first introduced in the nineteenth century. Electronic waves are clearly shown to be merely an example of how waves are part and parcel of this universe. With a unique approach, this book shows how to construct and handle any universe such as a technical universe or any component thereof such as waves.

Chapter 10 presents experimental proof of existence of waves, an important step in any scientific endeavor, where anything proposed must be proven. This is a remarkable step in the discovery of waves and Dr. Radmanesh has done a superb job in providing the reader with a clear understanding of what goes into making a successful hypothesis, along with accurate methods to perform scientific experiments to prove the hypothesis.

The subject of electronic waves has been a gateway to wireless networks, cellular phones, Global positioning system (GPS), Microwave Monolithic integrated circuits (MMICs), etc. The inventions and scientific developments in this and the last century provide a glaring testimony to this.

There are Eight supplemental discoveries, which are presented in Chapter 11 with an eye to their practical applications and how they can be used in the solution of actual problems dealing with different aspects of electromagnetism. These supplemental discoveries help to obtain quick answers to many complicated technical problems facing the professionals in this fascinating field.

Chapter 12 treats the reader to a delightful discourse on the author's vision of what lies beyond the physical universe. It presents a stimulating view of what forms the make-up of any science and presents a clear view of our complex physical universe both on a classical as well as quantum mechanics level.

In Chapter 13, the author makes several concluding remarks in what he hopes will be helpful suggestions in bringing about a revitalization in thinking for scientists and engineers, and methods of education of current and future science students and/or inventors.

The basics are explained clearly and the powerful principles of electricity are expressed lucidly and dynamically, providing a keen impression in the reader's mind. It is written for technical as well as non-technical readers and should serve as a valuable resource for

professional engineers, scientists, teachers, undergraduate/graduate students, interested but non-technical individuals, and technical managers.

The significance of this work lies in the manner in which it explores the fundamental postulates forming our universe and presenting them to the scientific community for the first time. Furthermore, the book makes a definite connection between the field of electricity and the broad aspects of our material universe, and does it with tremendous simplicity while making the reader aware of more intricate aspects of our sciences.

Finally, this book through its clarity and straightforward style of presentation provides the scientist as well as the non-technical individual an opportunity to appreciate the relationships between two seemingly unrelated universes: the “physical universe” and the “thought universe.”

**Dr. Asad M. Madni, CEng., FIEEE, FIEE, FAAAS, FNYAS, FIAE, FIBA
UCLA Alumnus of the Year Award, 2004**

President & Chief Operating Officer, BEI Technologies, Inc.

Preface

A few years ago the author published a popular text entitled "Radio Frequency and Microwave Electronics, Illustrated," which was well received by the scientific community and at the time it appeared that some of the main goals set forth by the author in writing the book were fulfilled. However, the main public who were not technically oriented or mathematically gifted did not instantly gravitate toward this work. Thus an attempt to present and bring about a general understanding of sciences, particularly the field of electronic waves, was begun.

Almost anyone in today's highly technological society strives toward a higher understanding of the inner workings of electronic equipment and desires to know the major principles behind this fascinating form of energy called electricity and electronic waves, and yet most electrical books present the basic concepts with so much complexity and filled with so many mathematical equations that the average public individual has given up on the subject and perforce has decided to retire to the sideline to be a spectator on the subject. In other words, their hope has been dashed aside and their dream of a higher understanding has not been fulfilled in any of the modern texts on electricity.

Furthermore, the subject of waves, particularly electronic waves has been piecemealed to a point where every text covers only a small part of the subject and leaves the rest to someone else to develop. At the present moment there is no coherent and one-stop approach that covers this material from A to Z and presents it in such a way that average public can wrap their wits around it. There has been a need for such a text for quite sometime.

Over the last hundred years, the field of electronic waves, initially placed on a firm ground by Maxwell, has grown and blossomed magnificently, primarily in the area of applications to match up with

the mathematical sophistication with which Maxwell's equations were presented.

The present work is the culmination of many years of study, observation, and pondering on the dilemmas and enigmas of propagating waves and their origin and the resultant understandings that was extracted from this sophisticated and at times incomprehensible field of study.

The scope of this work begins by examining the scientific fundamentals in Chapter 1. Then in Chapter 2 we do a thorough analysis of the physical universe and its three original postulates leading to four constituent components which are the application mass of four primary postulates. In Chapter 3, we study the workable postulates of physics along with implicit and hidden postulates that have established a workable field of study called the classical physics.

Chapters 4 through 9 present the universe of Electromagnetism and waves based on 6 monumental discoveries. Evolution of this universe is shown to be merely an example of how one can apply the principles (presented in Chapters 1 through 3) to postulate a desired universe into existence and then construct it. One of the examples of a created universe is the physical universe, which includes any of its constituent components (e.g. waves) or an application mass (e.g. an antenna).

Chapter 10 presents experimental proof of existence of waves and the validity of "the wave theory" as proposed by James Clerk Maxwell. This is an important step in any scientific hypothesis, where it is put to the acid test of experiment and physical proof. This is a shining chapter in the history of evolution of the wave theory, where Maxwell's genius in predicting physical phenomena (Radio waves) preceded years before its actual observation and discovery.

Chapter 11 presents 8 supplemental discoveries that have helped filling in the small gaps of knowledge that have been left behind and as a result made electromagnetism to be recognized as a dominant force in our modern society and help the practitioners in this field achieve a fast solution to many of the technical problems facing them.

Chapter 12 discusses what lies beyond the physical universe and what lies ahead of this universe. This chapter takes the reader to a vista never examined before by any scientists to this depth. The reader is treated to the final and concluding chapter of what lies beyond the physical universe. It brings an in-depth analysis and view of what forms the woof and warp of any science and makes one grasp the deeper meanings that exist in any universe.

The book's final chapter (Chapter 13) is the conclusion, which summarizes and highlights the most essential aspects of the book. This is where the author makes several concluding remarks and adds the final touch to what he hopes to be a major factor in bringing about a renaissance in:

- a) Scientific thinking for professional scientists and engineers, and
- b) Methods of education of science students all over the world and for many generations to come.

The book ends in several appendices. The last appendix is devoted to the numerical solution of some of the examples in the book. This is where all of the numerical answers to different problems are located.

In preparing this book, the emphasis was shifted from sophisticated mathematical solutions and shifted to conceptual understanding of the material contained in the postulates and axioms of a science. Instead the complex mathematical equations have been transferred to the many appendixes in the back of the book. The emphasis has been aptly placed on workable postulates of physics and essential principles of electromagnetism and the related discoveries using simple concepts while emphasizing the basics all the way.

Throughout this book the reader will be delighted to find numerous examples of actual application mass that has been developed through the years by very bright minds and practitioners of this field. The focus is on some of the basic applications of the electromagnetics to many different fields of study including, electrical circuits, magnetic circuits, RF engineering, microwave systems, electronics and photonics.

It is an interestingly uncommon book written primarily for the technical as well as the non-technical man. It is intended to serve several classes of our society

- a) The professional engineers,
- b) The technical inventors,
- c) The technically versed individuals,
- d) The interested but non-technical individuals,
- e) The college professors,
- f) The business and industrial leaders,
- g) The college and university students, and
- h) The professional scientists.

The book can be used for professional and practicing Engineers in the field, and business or industrial leaders, who are the visionaries of their group. It can also be used for inventors of new devices and gadgets. Most inventors would like to go to a source, where the initial spark of invention can be ignited. This book will surely serve as well this important class of our society—the technical Inventors.

For the average man who may or may not be technically versed and yet desires to learn about the universe at large, or the technical world in his immediate surroundings. It is intended to lift the aura of “black magic” surrounding the world of sciences particularly electricity, to enlighten and demystify the subject of sciences in the minds of ordinary individuals.

The Importance of Work

Rather than looking into the complicated mathematical equations for solutions, Man's long search for answers to the riddles of the technical world will finally be amply rewarded through the pages of this book. By avoiding undue complexities, the reader will achieve occam's razor doctrine and will be actually traveling in the direction of “the actual why” and thus be able to put his thoughts on the right track for all the future problems forthcoming.

Within the confines of this book, one is given a chance for the first time to take an in-depth look and inspect first-hand, one of the most dynamic fields of study that has ever been developed in the history of mankind on this planet. The basics are laid in simple terms and

clear explanations express the powerful principles lucidly and dynamically, providing an unforgettable impression in the reader's mind.

The scientist, armed with the tools solidly laid out in this book, will be well equipped to understand scientific journals and handle the problems of work-a-day world of sciences, particularly testing, analysis, and design of devices, circuits, and systems dealing with electric, magnetic or electronic wave phenomena. The increased depth of knowledge will allow one to achieve one's objectives with a much higher probability of success in this rapidly advancing subject.

The broad importance of this work could be summed up as a totally new approach to understanding our scientific world through the use of newly discovered fundamentals (missing in all technical books), which add a tremendous amount of simplicity and clarity to very complex problems.

This is a new approach unmatched in any extant text today. The discovery of these fundamentals has had a huge impact on our current world and has truly made our scientific arena a bright beacon of hope with a renewed interest in understanding our physical universe. This work has created a “unified theory “about the physical universe and the thought universe in very simple terms.

Finally, this work paves the way for the scientist as well as the non-technical individual to formulate and develop a relationship between two distinct universes: the “Material or Physical Universe” and the “Universe of Thought”.

The Scope of Work

The current work can be used to serve as a textbook for a course in physics, electromagnetics, RF electronics, microwave Engineering and the advancing field of photonics. It is intended for all levels of college particularly for senior-level or graduate students. It can just as well serve as an excellent reference guide for the professional scientist, practicing engineer, whether in electromagnetics, RF and microwaves, electro-optics, or general sciences who is actively involved in his/her respective field.

The book starts from the very general postulates, considerations and laws and presents an example of these principles with the introduction and evolution of the universe of electronic waves. The book, divided into four parts and 13 chapters, presents these chapters with the progressive development of concepts following the same pattern as presented in the pyramid of knowledge in Chapter 1, which is:

A) PART I- THE PHILOSOPHICAL FOUNDATION OF SCIENCES

Chapters 1-3: Present a framework for any science and analyze the physical universe by putting forth the three original postulates and the derived primary postulates that created it. Moreover, the workable postulates of physics are discussed in depth and through introduction of the hidden and implicit postulates, the potential pitfalls of the subject are exposed.

B) PART II- ELECTRONS TO WAVES: THE MONUMENTAL DISCOVERIES

Chapters 4-6: Present the progressive development of electricity and magnetism and state the three monumental discoveries that brought them to the forefront of technology.

Chapters 7-9: Deal with the final saga of electromagnetism as a unified science, as it was discovered and how it came to its full fruition.

Chapter 10: Introduces the experimental proof of waves and shows conclusively the existence of waves. This was the crowning moment for Maxwell and his wave theory, who predicted the existence of waves long before its discovery.

Chapter 11: Introduces the supplemental discoveries, which help to fill the gaps of knowledge in electromagnetism and to elucidate those subordinate concepts, which were not touched upon in the previous chapters.

C) PART III- THE FUTURE AHEAD

Chapters 12-13: Discuss what lie beyond the current universe and presents a summary of the basic scientific considerations that underlie all of our current sciences and technology. It also points out to the universe ahead and what would the future bring at the current pace of scientific developments.

D) PART IV-APPENDICES

A list of symbols used in each chapter and a series of quizzes are included at the end of each chapter to aid the reader gain a fuller understanding of the presented materials. The book ends with a glossary of technical terms and several important appendices. These appendices cover physical constants and other important data needed in the process of understanding of the material covered in the text.

The Author's Goals

As part of the author's goals, the presentation of a number of scientific fundamentals pours the foundation for understanding our complex universe particularly the universe of waves. They provide a rather deep philosophical bed-rock upon which the weight of the rest of the ensuing complicated concepts can be supported.

Moreover, with the help of this foundation, the author intends to achieve several milestone achievements:

- a) Create a better perspective toward application of sciences especially electricity and electronic waves,*
- b) Promote a better and deeper understanding of the scientific methodology, and how it is used to achieve stellar results in the scientific arena,*
- c) Bring about a public awareness of sciences and how the universe of waves affects us in many ways on a constant basis and how a simple knowledge of the subject leads to a plethora of applications.*

The full “pyramid of knowledge,” pertaining to the field of waves, has been streamlined and presented in a simple language. This missing element (pyramid of knowledge) from the field of science and engineering as well as education has created a truncated science where the top half of this pyramid is cut off. This vital amount of information missing from any subject invites disaster for its students and followers. It would surely create great turmoil in the minds of people associated with sciences (e.g. students, educators, designer, etc.) all over the world. The brief presentation of these basics in this chapter is expected to bring about nothing but a small renaissance in the scientific arena as a whole particularly in the field of waves, electricity and magnetism which are rapidly advancing fields.

The tools used by the pioneers and founders of sciences are the tools of today’s successful scientists, who strive to succeed in their profession. By knowing these materials well, the reader will be taking the same route that all the great men and women of sciences took to achieve their remarkable discoveries that we are all benefiting from.

The non-technical reader will be invited to examine a series of basic materials that will enable him/her to understand his immediate universe far better than ever before. He/she will be exposed to materials of considerable significance, which surely would open up the gates of knowledge along with a wider horizon of understanding.

For professional engineers or science students who are armed with these tools as their stock-in-trade, they are equipped well to understand scientific journals and handle the problems of work-a-day world of sciences, particularly analysis and design of devices, circuits and systems dealing with electric, magnetic, electronic waves, etc. Their depth of knowledge will allow them to achieve their objectives with a much higher probability of success in this magnificent arena.

The Reader's Feedbacks

The author would always like to hear from his readers and considers this feedback a valuable communication line for corrections and suggestions. It is the author's basic philosophy of life and one of his greatest joys, to be able to extend a hand of friendship and help to

others and let them share their understandings and realizations while reading this work. This would undoubtedly lead to an enrichment of one's life in the process and would empower one to reach greater heights of understanding and a more enlightened life, which would make this world that much a more pleasant place to live in.

Any communications in the way of a healthy criticism and/or correction are welcome. Moreover, the author considers it one of the most rewarding things to have another individual grasp the materials in all of its simplicity and realize the true purpose of sciences, particularly electricity and then use it intelligently and ethically to increase mankind's potential survival in this universe and help others to achieve their goals and in the process make Man take control of his own destiny, without being shackled by the chains of higher authority or superstition.

Therefore, in order to improve the quality of this work author would like to have all comments or suggestions be sent directly to:

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January 2005

PART I

**THE
PHILOSOPHICAL
FOUNDATION OF
SCIENCES**

**CHAPTER 1 THE SCIENTIFIC
FUNDAMENTALS**

**CHAPTER 2 ANATOMY OF THE
PHYSICAL UNIVERSE**

**CHAPTER 3 THE WORKABLE
POSTULATES OF PHYSICS
AND ENGINEERING**

Chapter 1

The Scientific Fundamentals

1.1 THE MIRACLE OF WAVES

Radio waves have actually existed since time immemorial, which is the beginning of the physical universe many trillions of years ago. Man's appearance on this tiny planet (earth) on a far and remote star system (solar system) near the edge of the Milky Way galaxy has been documented to be less than 100,000 years ago. And yet through this whole time period, waves of all frequencies, visible and invisible to the eye, have existed and yet Man was far too busy in his many social upheavals, too involved in his fight for survival on a physical plane or perhaps plainly unaware to notice and thus know about this truly miraculous subject.

Over a hundred years ago, Man was finally made aware of "radio waves," this fantastic civilizing factor and world has not been the same ever since. Moreover, as it turns out radio waves are but a subset of a much larger field of study called "electromagnetic waves", which will be taken up in depth later in this book.

The miracles we hear everyday today (such as satellite communication systems, infra-red and fiber optics systems, microwave systems, wireless networks, cellular phones, etc.) were just unheard of a hundred years ago. Man was still trying to understand Maxwell and what he had predicted mathematically. No one was prepared to embrace the legacy of the wave theory, the way Maxwell had presented it.

Years had to go by before Man came to full understanding of this subject and along with it came an avalanche of applications. The last hundred years compared to the one hundred thousand years of existence of Man on this planet is of far more significance that has ever been envisioned or anticipated by any single individual.

The tooth and claw age has suddenly disappeared and Man has been put in charge a much finer type of energy than he has ever been accustomed to. He is gradually getting used to this fine level of energy and is taking big strides in the direction of conquering this planet and exporting his technology to outer space.

The door to space explorations has gradually opened up and a new age has been ushered in. This new age, which Man is just standing at its threshold, is the age of space opera. This new age has been preceded by many ages, important amongst them are the age of communication, age of industrial revolution, age of electronics, age of computers and age of information. The age of "space opera" is different than the "space age". The latter is the age of outer-space exploration through manned or unmanned vehicles, and is the period starting October 4, 1957, with the launching of the first artificial satellite, which followed later by many manned vehicles. This age of space exploration will be gradually phased out as Man's knowledge about the outer space increases and thus a new age, i.e., the age of space opera, will be ushered in soon afterwards.

The age of space opera is in the not too distant future of mankind and is considered to be the age of interplanetary travel and migration to other planets in this or other galaxies using space vehicles having speeds far greater than anything possible on earth or any interplanetary rocket currently in use today. An example of space opera society is best illustrated in the many episodes of the popular motion pictures of "Star Wars" and "Star Trek".

Reality of this space opera era is a relatively new subject to Man. The subject has been kept alive for years by science fiction writers and the movie magic has added an aura of awe and mystery to it. But this age actually owes a great deal to Maxwell and his predecessors (such as Faraday, Ampere, etc.) who enabled him to predict the existence of the invisible "radio frequency waves" and thus walk the last mile mentally, before Hertz showed its existence physically, years later.

The discovery of waves was perhaps the greatest scientific triumphs of the nineteenth century science and with it mankind was empowered to soar to greater heights never imagined by any visionary scientist or philosopher.

1.1.1 Electrons to Photons

The story of modern sciences and along with it our current highly-technical civilization started from the discovery of electric charges (or electrons) some four hundred years ago and ended in its connection to photons three hundred years later. This journey was an evolution for mankind, in awareness of the finer particles of this universe. It might as well be called the age of electrons followed by the age of photons, much similar to the much cruder ages of the past such as Stone Age, Metal Age, etc.

Truth be told, the story of “electrons to photons” has had a very dim beginning circa 600 BC, which truly was not the beginning until 2200 years later, when William Gilbert made his first scientific observation and study of electric charge in 1600 AD. Centuries went by and many discoveries were made along the way, which paved the path for James Clerk Maxwell who announced his brilliant prediction circa 1873.

In simple terms, Maxwell’s prediction can be simply stated as “Any Electromagnetic radiation, including light rays (or photons), is a byproduct of oscillating electrons”. This prediction even though not well received by his contemporaries at the time had to wait over two decades until Heinrich Hertz experimentally proved Maxwell’s theoretical assertions in 1894.

Over the last one hundred years, Man has gone beyond these breathtaking discoveries and has soared to new plateaus of existence. In 1905, Albert Einstein announced his “special theory of relativity” followed by the “general theory of relativity” in 1915.

With the advent of theory of relativity, the “concept of viewpoint” was emphatically introduced into the realm of physical sciences. The announcement of the relativity theory startled the scientific world since this was a totally unlooked for arena for sciences in which to engage or revel.

Einstein’s work in relativity provided the first stepping stone between pure and hard-core physical sciences and the concept of “viewpoint”, which is part and parcel to life and existence. Therefore, the concept of viewpoint and its effect on the physical

universe and its related phenomena was included in sciences boldly for the first time.

This was a new concept, something the physical sciences were not prepared to embrace and, in fact, had tried to flee en masse centuries ago. This was an unknown territory and almost forbidden to walk into, due to the close association of viewpoint with philosophy, a subject considered by scientists to be riddled with arbitrary factors and no possibility or existence of any proof, mathematical or otherwise, of any of the asserted statements.

Therefore, scientists found themselves on uneasy grounds and ever since that time, most of the efforts in further exploration of relativity and possible reunification of sciences and philosophy has amounted to nil. This is so, because since the Einstein's monumental work on relativity, which showed the viewpoint dependency of our physical universe, most of our current scientific activities have been relegated to:

- a) Development of new application mass, which are invention of new gadgets, devices and systems to make life tenable,
- b) Investigation of particles (beyond electrons and photons), which make-up our physical universe, and
- c) Deep space exploration for the existence of new worlds and possibly new life, etc.

In short, the road that Einstein opened up and for which gained world-wide fame has been dead-ended and can be considered at this time mostly abandoned by modern scientists.

It is in this climate of uncertainty about the concept of viewpoint that this book is introduced into the scientific world. It is not so much the intent to continue Einstein's work on relativity but to resurrect an old relic of a concept that has been dormant for almost a century.....

CHAPTER 2

The Anatomy of the Physical Universe

2.1 THE BIG PICTURE

Man is fortunate indeed. He finds himself in a body, a low combustion carbon–oxygen engine, a physically feeble entity, which can not tolerate much force. It seems that he has been left alone in a very desolate place. He is an inhabitant of a thin crust of a minor planet of an inconsequential star in just one of the millions of galaxies in the universe. However, he is born with the ability to observe, to communicate, to reason and to understand his surroundings and thus be able to solve his essential survival problems, and moreover, find out his relationship to the physical universe in which he is intimately associated with.

Man does not merely exist or survive on a tooth and claw or by rote and instinct basis like the rest of the earth creatures. He asks the why and how of things. To find answers to the mysteries and riddles of this physical universe, he looks into and under and behind them. He has the ability to ponder problems of existence and survival and come up with workable solutions, if not perfect!

Man is not an amoeba inhabiting earth, which is floating aimlessly in the seemingly boundless space of the physical universe. He is not matter but the life force that imbues life into matter and energizes the physical body. The product of the two is a complex being that has an understanding and an awareness of the physical universe, a high propensity and an ever-increasing capacity to shape it to his own needs and desires.

While being in a body, Man can not begin to grasp the magnitude of the created space surrounding him physically; however, intellectually he has grasped this concept and its origin. His constant search for the answers and use of very powerful instruments has enabled him to probe deeper and deeper into the cosmos. His computation at this time indicates that we live in a physical universe with an approximate diameter of 8,000,000,000 light years (8×10^9 or 8 billion light-years, ly) or a radius of 4 billion light-years. Now, considering a light year to be the distance that light, at the speed of 186,000 miles per second travels in one year, we find that this is unfathomably a large number relative to the size of a human body. Considering the existing modes of transportation, their speed, and human life span, we find these distances to be impossible to travel.

In this sea of created space, there are billions of star atolls, (i.e. the galaxies) each containing billions of stars, clouds of hydrogen and dust. While the average size of a star is about the size of our sun, which fits a million earths within it; however, there are stars that could fit a million suns.

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| a) The professional engineers, | e) The college senior and graduate students, |
| b) The technical inventors, | f) The interested but non-technical individuals, |
| c) The technically versed individuals, | g) The business and industrial leaders, and |
| d) The college professors, | h) The professional scientists. |

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