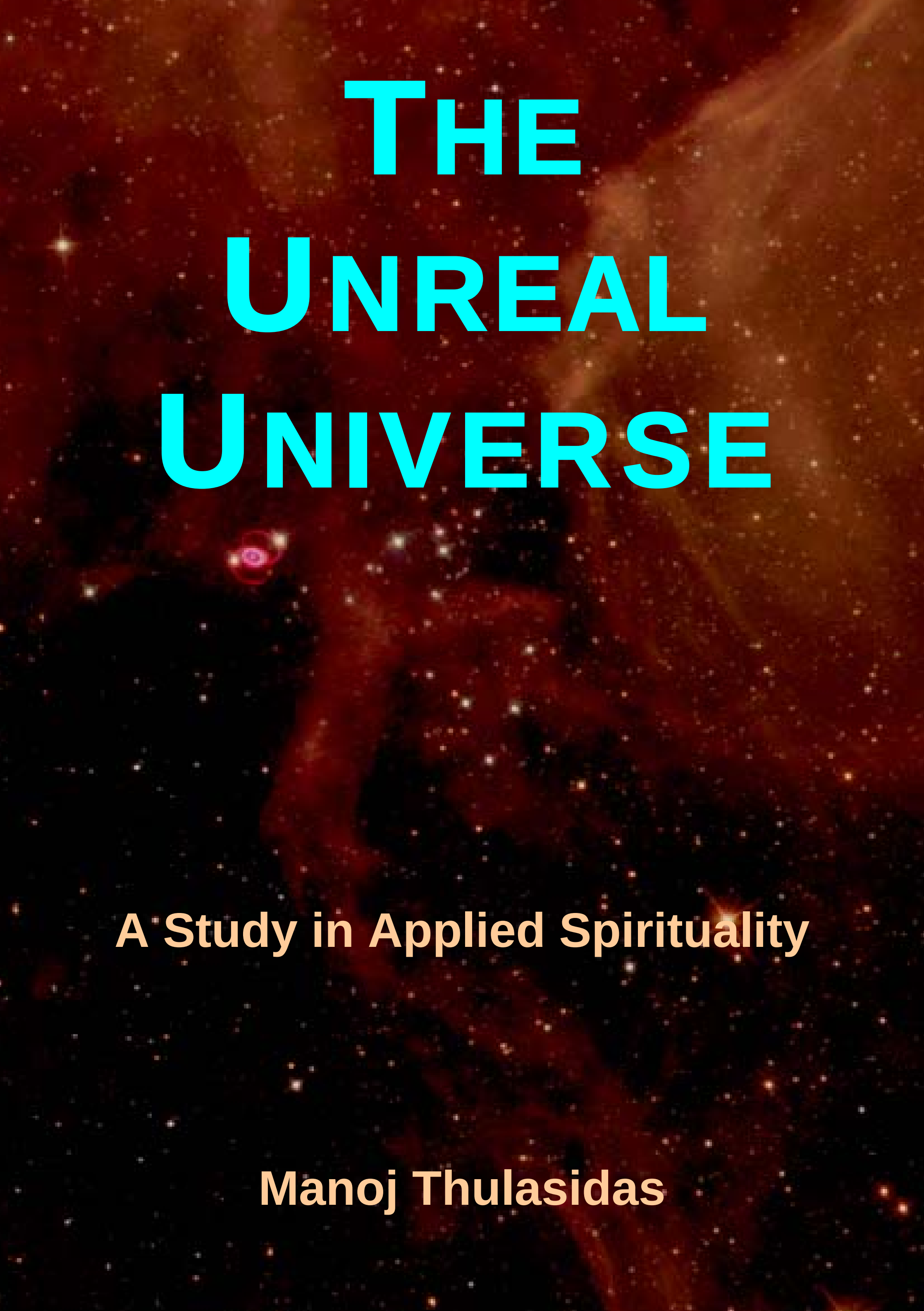

The Unreal Universe

A Study in Applied Spirituality

Manoj Thulasidas

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Asato Ma Sat Gamaya
Thamaso Ma Jyothir Gamaya
. . .

From the unreal, lead me to the real
From darkness, lead me to light
. . .

—Brihad-Aranyaka Upanishad

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Acknowledgments

Newton once said if he could see farther, it was only because he was standing on the shoulders of giants. Our collective wisdom is not something we create over a generation, nor the genius of one inspired giant. It is indeed by standing on the shoulders of giants like Newton and Einstein and Feynman that we look tall and see far. In my delusions of grandeur, I believe that I will look tall some day and I acknowledge the giants for any potential gain in my stature. And, I would count not only the giants of modern sciences, but also the unknown or understated giants of the spiritual world of the past, both Eastern and Western.

Along with the giants for their inspiration, I would like to thank the people who stood by me. They are all giants in their own right, at least in their influence in my life. I start with the first (and admittedly biased) fan of *The Unreal Universe*, my father. In his endless patience with my childhood questions, I now see the roots of my irreverent skepticism of scientific authority. Next is my wife, Kavita, whose undying faith in my genius is probably behind the afore-mentioned delusions of grandeur. Most of all, I thank my children, Anita and Neil, who had to pay (not always willingly) for this book with their dearest of resources—their time with me.

Writing a book is a daunting task, especially for a non-writer. But I had some help from my friends, and I gratefully acknowledge their encouragement, frank comments, discussions and proofreading.

M.T.

Preface

The universe turned unreal on me in early 2004. That is when I started writing down my thoughts, at first as unrelated philosophical musings, and as a more coherent thesis later on. These random notes slowly evolved into *The Unreal Universe*. In its final form, the book may look like a well-coordinated and logically coherent attack on your sense of reality, whether you agree with its arguments or not. But that is not the way it was originally written. Here is the story of how a perfectly fine universe turned unreal.

If you grow up in a place like India, it is a bit hard not to end up with a slightly philosophical bend of mind. Because of all the philosophy in the air, some of it is bound to get into you almost osmotically. One school of philosophy that I came across fairly early in life is the *Advaita* line. The word *Advaita* means unduality or not-two, signifying the oneness and indivisibility of the universe. To me, it meant something slightly different. I understood *Advaita* like this—if you were to generate all the electrical nerve stimulations in my brain, you could possibly give me a false sense of reality. If you did it right, it would be impossible for me to tell the difference between a "real" universe around me and the universe you created in my head. In this sense, the universe is not outside me, and the universe and I are not two, *voilà Advaita*! I later understood that this interpretation of *Advaita* is what all students of philosophy hear in their first lecture in epistemology. This is nothing but the brain-in-the-vat and evil genius thought experiment that was most skillfully dramatized in the movie Matrix. Thus, my understanding of Eastern philosophies always had a bit of western flair to it.

The next level of exposure to philosophy came in my adolescence in the form of yoga. This interest in yoga was spawned by a book my father gave me, called *Yogic Cure for Common Diseases* to help me fight my asthma attacks. Till the age of twelve, I had regular asthma attacks (strangely correlated with lunar cycles), and they were troubling me again in my late teens. I followed the *yogic* cure and was really impressed with the prompt and lasting results. This induced me to read up books on yoga by Swami Vivekananda on various branches of yoga. And true to the *Advaita* philosophy, in India, everything is somehow connected. Yoga, whether as a physical activity or a meditative means to understanding the purpose of life, is also a part of the ocean of philosophy that is Hinduism.

Around the same time, I also got into a bit of existentialism. I read *The Outsider (L'Étranger)* and *The myth of Sisyphus* by Albert Camus. I suspect that the real reason behind my fascination for Camus was that I could quote from these books and sound really cool. Nonetheless, I did find something deep and vaguely troubling in *The Outsider*, so much so that when I learned enough French years later, *L'Étranger* was the first book I tried to read.

All through these early years, I always did well in physics. I would like to think that this facility of mine in physics had something of an aptitude that harbingered a greatness to follow in later years, but I suspect the reality of it may be much more prosaic; a mathematical ability in a certain subject is quite far from the greatness of a genius. But physics did make sense—until I realized that it did not really explain anything. The role of physics is in describing our universe with mathematical exactitude, which may be pointless in the absence of an ability to understand anything. What does it matter that an electron has a unit negative charge if you don't know what a negative charge really is? What does it mean to say space contracts or time dilates when you don't even know what space and time are? The difference between a description and an explanation is like the distinction between knowledge and wisdom, or between a reply and an answer. My disillusionment with the way physics provides replies to basic questions may have been the reason why I jumped at the first semblance of an answer that came my way.

But the answer didn't materialize all of sudden. The insights and revelations in this book, though presented as direct logical deductions, are in fact an accident of circumstances. My physics background and philosophical bend of mind played a role in embarking on this knowledge adventure. I have always pondered over questions like, "Are we capable of understanding how the brain works?" and, "Is time real?" The first inspiration to ponder over the unrealness of reality itself came from some simple statements from the BBC Reith lecture series, "The Emerging Mind" by the eminent neuroscientist V. S. Ramachandran. These lectures impressed upon me two notions, which were not really the main points of the lectures. The notions were:

- Reality is a representation of the sensory inputs.
- When encountered with a sensory or cognitive conflict, the brain resolves it by creating a reality most consistent with the conflicting inputs.

I felt intuitively that if an object moved faster than the speed of light, it would appear at two places at once as two objects, which I called "phantom objects." And I thought this unnatural mirroring would be a sensory conflict that our brain would try to resolve by creating a reality in which superluminality is forbidden. I know that this is not a strong line of argument, but once you accept that reality *is* a model created by the brain, the argument is fairly iron-clad. Reality really is only a representation of our sensory inputs. How deep that statement runs and how it was articulated in some branches of philosophy is the initial part of the book. How it can be *quantitatively* applied in physics is the second half of the book—a train of thought that will explain why the speed of light is a special number in our reality.

While working out the algebra to prove the existence of the "phantom" objects, I realized that I could think of the theory of special relativity as a formalization of this view. To me, this revelation was indeed a breakthrough. However, this philosophical interpretation of the Einsteinian space-time would not be strong enough to convince the world of its validity. So, I thought I needed to find concrete examples which would illustrate the validity of my view. I did find them; they were gamma ray bursts and symmetric radio sources. These phenomena are poorly understood in the models currently popular in astrophysics, but they find simple and natural explanations in my view of the universe as a perception made out of the light inputs to our senses.

The role of light in creating our reality or universe is at the heart of western religious philosophy. A universe devoid of light is not simply a world where you have switched off the lights. It is indeed a universe devoid of itself, a universe that doesn't exist. It is in this context that we have to understand the wisdom behind the notion that "the earth was without form, and void" until God caused light to be, by saying "Let there be light."

The philosophical arguments in the book went through quite a bit of metamorphosis during the last couple of years. When I started writing down the notes that later became the book, I was thinking of the "absolute reality" to be pretty much like what we do see around us—the "perceived reality." Later, I realized that there was no reason for the absolute reality to be anything that is even remotely comprehensible, or to have anything in common with our perceived reality. This complete disconnection between what is out there and the way we see it actually ties in nicely with some of the notions of the *Brahman* in the *Bhagavat Gita* and *Advaita*.

And, in my mind, it also explained why it is so difficult for normal physicists to accept this view. After all, physics is a meticulous mathematical description of what we perceive to be out there. What is beyond our perception (and the consequent cognition) is beyond physics. Perhaps rightfully so. This book, however, is my attempt to rope in the "beyond" into physics, or a variant thereof, with the honest conviction that this is the only way to augment our knowledge.

The organization of the book is something that I agonized over for many months. The early feedback from my proofreaders indicates that the current presentation favors people with a background in philosophy. Readers with a scientific or technical background may find the physics part more compelling and may want to start from there. One such reader remarked, "When I reached the physics part, I could immediately see what you meant by unreal was. Why wouldn't you start with physics?" Physics suffers from an unfair reputation of difficulty, as one of my non-technical readers put it tersely, "Aarghh...! Formulas? Seriously....!" when she reached the physics part. In order to ally this popular fear of the subject, I decided to present the philosophical arguments (with some excursions to neuroscience) as the motivation for the necessary physics that would follow.

The current organization of the book, however, has the drawback that the initial philosophical chapters are a physicist's take on metaphysics and spirituality. A philosopher would have probably put it as a critique on reality, as a friend of mine with a PhD in religion suggested that I should have done. However, the metaphysical unrealness of reality, which is so obvious to philosophers, may not be obvious at all to the rest of us. It certainly wasn't, to me.

MANOJ THULASIDAS

Singapore

March 8, 2007

Introduction

The only true wisdom is in knowing you know nothing.
—Socrates

This book has its origin in the insight that all our knowledge is interconnected. This underlying connection is not surprising in some cases—for instance, between physics and philosophy, or between neuroscience and biology. But when it comes to highly specialized fields, the link becomes less obvious. Why would there be a link between, say, the theory of relativity and evolutionary biology? Or, between the fundamental interactions of particles and the epistemological limits on knowledge? Yet, such a link exists. Once identified, this link helps us understand some deep questions ranging from philosophy to physics. It shows us how physics is limited by our perception, why space and time behave the way they do, and why the speed of light is so fundamental in our reality. Everything begins to fall in place, like a jigsaw puzzle. It is this excitement in understanding and organizing large swathes of knowledge using this new found link that this book strives to share with its readers.

This interconnection in human knowledge may seem unremarkable at first glance. Of course, everything is linked, the entire body of knowledge that we possess resides in our brain, and that is where it is linked. In order to make use of this seemingly trivial interconnection, we need to appreciate the real import of the statement, "Knowledge resides in our brain." What is knowledge? Is it merely the product of our logic and deduction? Does it also include the objects and assumptions that our logic operates on? How about the space and objects we see, the sounds we hear and everything else we sense? Where does knowledge end and reality begin? It turns out that reality is not distinct from knowledge. Reality itself is nothing but a representation in our brain, a convenient mapping of our sensory inputs. This is how cognitive neuroscience treats reality. This is also how certain lines of Eastern philosophy view reality.

This overlap between science and philosophy on the subject of reality can be applied in understanding certain aspects of physics in a quantitative way. If reality is merely a model based on sensory inputs, any limitation in the chain of sensing should have a manifestation, a measurable and predictable effect, on our reality. And, because reality is the input to physics, its theories have this manifestation built in. Can we identify the limitations of perception and disentangle their consequent manifestation from physics? This question is the central theme of the book. Once the scientific view of reality as a representation of sensory perceptions (rather than the philosophical truism that nothing is real) percolates to physics, what is explored in this book will become part of our basic knowledge. We will clearly see the role of sensing and perception in physics and its theories.

The theme of *The Unreal Universe*, namely the interplay between spirituality, philosophy and science, has always fascinated us. Our curiosity is at its highest when it comes to the workings of the brain and how they are reflected both in physics and philosophy. For this reason, the book uses intriguing examples from neuroscience to examine the fundamental concepts of time and space, and our sense of reality in general, highlighting the link between some branches of philosophy and science.

Western philosophy provides the basis and methodology for modern science, while Eastern philosophy looks suspiciously similar to cognitive neuroscience in its notions of reality. It is from this intersection between the sciences and philosophy that our deductions in physics part are made.

The physics part starts with a "Primer," which describes all the physics needed to follow the rest of the book. The description is textual and conceptual, using no mathematics. Even the subsequent "quantitative" application of disentangling the limitations of perception from physics is described without any equations. The reason for this level of presentation is not merely its appeal to a wider readership, but also the necessity to enlarge the reader's context of conceptual thought. A wider context is essential in order to accept a philosophical or spiritual interpretation of physics. The soundness of the conceptual context is more important than the completeness of the technical details; but for those interested, the technical details can be found in the Appendix. Though technical, this Appendix should also be easy to read through because the reader has gone through the conceptual description first. But it may appeal more to those with a strong interest in physics.

Any path we take in the realm of knowledge seems to be closed on itself, like a circle. This is true of the particular path that we will explore in this book as well. Here, we start with philosophy. The genesis of philosophy is in our logic and thought processes, which take place in our brain. So how the brain works (neuroscience) is pertinent to our studies. The workings of the brain are dictated by its development over the ages through evolution. So we also need to understand how and why evolution sets scales and limits to our brains' operation and our senses. The senses are vitally important in our study because they interface our brain to the physical world that we set out to describe in physics. Physics also describes the processes that give rise to our mental activities, thought process and logic. And in the end, the thought process and logic are the basis of knowledge and philosophy, completing the inescapable circle of knowledge. This circle is reflected in the organization of this book.

The foundations of physics are the concepts of space and time. In the first half of the book, we examine our perception of space and time. After that, we look at reality and how it is created in our brain. The nature of reality is the subject matter for some branches of philosophy. We take a quick look at different branches of philosophy, both Eastern and Western, and see how they view our sense of reality and how they provide the basis for physics. Then, in the second half of the book on how our sense of reality influences physics, we start with a refresher, then look at the structure of matter and the universe from a physicist's point of view.

At that point, we will be ready to apply the notion of reality from philosophy (and neuroscience) in answering some real questions like the reason for the specialness of light in our universe and how the theory of special relativity is related to the notion of reality. We will see that the constancy or sanctity of the speed of light is a *consequence* of our perception, and does not have to be an *assumption* on the nature of space and time. Based on this understanding, we will examine certain astrophysical and cosmological phenomena in some detail.

In the course of this book, we will see how physical sciences (with the notable exception of quantum mechanics) trust the perception of reality. The perceived reality is assumed to be a fairly accurate description of the external reality. This external, absolute reality is assumed to be something that can be sensed or measured in finer details with better technology and observational instruments. However, according to neuroscience, the perceived reality (or the phenomenal reality) is only a representation of our sensory inputs, modulated and even distorted by our brain's processing. This distorted version of an unknowable absolute reality is our *Unreal Universe*.

Why would our brain distort our perception of reality? Evolutionary biology tells us why. We perceive reality the way we do only because this is the best way for us to perceive it and because this is the reality that maximizes our chances of survival. The optimization of our survival and reproduction is the basis of everything that our brain does, including masking the absolute reality and dealing only with a representation. The interesting twist to this story is that many branches of philosophy had already discerned this distinction between the absolute reality and our perceived picture of it. This ancient philosophical insight rediscovered in a scientific context is the backbone of this book.

Part I

Perception and Reality

1

Mother of Sciences

Science never solves a problem without creating ten more.
—George Bernard Shaw

The realness of reality is an inquiry appropriate to philosophy. The realm of science is reality as we perceive it. All constraints in perception are, therefore, mirrored in science. How can we identify and remove perceptual constraints from science, or at least, understand their manifestations? Before attempting to answer this question the next ten chapters, let's first look at how we organize our knowledge under different domains.

1.1 SCIENCE, PHILOSOPHY AND SPIRITUALITY

Science stems from the basic curiosity innate in all of us. Why is something the way it is? How does something work? Implicit in such questions is an assumed ability to answer them. Science represents that ability, that body of knowledge from which logical answers can be elicited at will. At the other end of the spectrum of knowledge is spirituality, representing our collective ignorance, addressing questions to which we do not have logically satisfying answers. What is right and wrong? What is the meaning of life? Philosophy sits in between these two, dealing with problems such as the nature of knowledge and reality. These vast domains of knowledge may appear to be distinct subjects dealing with totally different problems at the outset of a life of scientific investigation or philosophical inquiry. It takes the wisdom that comes with maturity to realize and appreciate the extent of the overlap among the three.

Philosophy is considered the mother of sciences. To a student of science whose faith is entirely with physical sciences, this claim may sound like the wishful thinking of a frustrated philosopher, but philosophy is a unique field. It addresses questions in every aspect of human life, and its techniques apply to problems in any field of study or endeavor. No brief definition expresses the richness and variety of philosophy; it is nothing less than the attempt to understand the universe as a whole. Its sphere of interest is boundless. It is a reasoned pursuit of fundamental truths, a quest for understanding, a study of principles of conduct. Philosophy seeks to establish standards of evidence, to provide rational methods of resolving conflicts, and to create techniques for evaluating ideas and arguments. These techniques, of course, provide the basis for modern sciences.

Despite this basic connection, philosophy seems irrelevant to physics mainly because of the apparent ease with which physics seems to answer the "why" and "how" questions up until the undergraduate years. Once one passes the undergraduate level, the arbitrariness of some of the assumptions and hypotheses in physics begins to shake the logical faith we have developed thus far. We may suspend our disbelief mainly because the theories, despite their arbitrary nature and extreme complexities, seem to work. But by that time, we realize that the role of physics is no longer to *explain* why things are the way they are, but to *describe* how they behave in a mathematical fashion. This role, of course, is a lot less satisfying. But it is when we begin to question the hypotheses themselves that we find ourselves on a slippery slope toward philosophy.

1.2 ASSUMPTIONS AND KNOWLEDGE

Nature's laws are tricky to figure out, but once we do figure them out, they are surprisingly simple. This simplicity is what Albert Einstein hinted at when he said, "Subtle is the Lord, but malicious he is not."[1] Simplicity also implies the absence of arbitrariness. For this reason, arbitrary assumptions and axioms to explain physical phenomena and complicated computations describing them should always be viewed with skepticism.

Some of the arbitrary assumptions in physics are easy to spot—*e.g.*, the speed of light is a cosmic speed limit; nothing can travel faster than light. This is one assumption we will go into in great detail. Another palpable assumption introduced in modern cosmology is the one about dark matter.

Dark matter was postulated to account for the speed anomalies in galaxies. The speed at which stars and galaxies should be moving was calculated based on the visible matter in galaxies. The calculated speeds did not agree with the observations. The celestial objects were moving faster than predicted, as though the galaxies contained more matter than the scientists could see. They postulated dark matter as the matter that could not be seen.

A similar ad hoc assumption of dark energy was introduced to account for another anomaly; the universe is expanding faster than it should be. Dark energy is the invisible force pushing things away from each other. Such ad hoc assumptions in physics are easy to spot.

The assumptions dealing with the nature of reality itself are far trickier to spot. Examples of such assumptions are: there is a three-dimensional space, there is a continuously flowing time, and so on. These fundamental assumptions are as philosophical as the statement that there is a God. In this book, we will ponder over these philosophical assumptions as well. We may not be able to explain away all these assumptions and arbitrarinesses. However, we may be able to see what they are based on, where they come from. Some of these philosophical assumptions are embedded so deeply in the way we look at the world that they form the fundamental concepts on which our physical sciences are built.

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[1] Also quoted as "God is clever, but not dishonest."

1.3 UNREAL REALITY

One of the foundations of physics is the concept of time. Time is so pervasive in our daily lives that we take its existence to be self-evident. Despite this appearance, time is in fact an abstract and arbitrary concept. It is a mathematical construct much like numbers. How such imaginary things as time and numbers could describe "real" physical phenomena is indeed a surprise. Later on, we will find a plausible explanation for the existence of time, not in physics, but in evolutionary biology. Evolution has played a large role in our perception, and thereby in physics. The role of evolution in our sense of reality (which includes space and time) is an insight that provides surprising answers to a wide range of questions.

While the realness of time may be logically debated, we never find ourselves suspecting space, because we sense and perceive it directly. Despite this direct perception, our faith in space is easily shaken by a cursory exposure to neuroscience and the study of consciousness. Losing faith in the realness of space is not all bad, because in the process, we gain insights into one of the most arbitrary assumptions in modern physics, namely the sanctity of the speed of light. The speed of light is considered a kind of cosmic speed limit for matter. It is also a constant no matter how we measure it (*i.e.*, irrespective of our state of motion). Once introduced to this assumption, the immediate question that confronts any serious student of physics is, what is so special about the speed of light? Why the speed of light? Why not some other number, the speed of something else? We will see later that the answer lies not just in physics but in neuroscience, in how our brain creates a reality for us.

The nature of reality used to be in the realm of philosophy or even religion and spirituality, but sciences have started staking a claim to it. In the last couple of decades, cognitive neuroscience has begun to understand the true nature of reality [1] as a representation of our sensory inputs. Reality is a model created by our brain. It is a representation that maximizes our chance of survival. Once this scientific understanding of reality (as opposed to a philosophical conjecture) percolates to other modern sciences (especially physics), what is explored in this book will become part of our basic knowledge.

We will see clearly the role of sensing and perception in the theories of physics.

The unreal nature of space and time may be a little unsettling at first. However, it is important to realize that our perceived reality is *the reality* we have to live by. It is this perceived reality that we have to describe in our sciences, that we have to build theories on. The physical causes behind the perception, the absolute reality of which our perception is only a representation, are largely irrelevant to us. This irrelevance is precisely the reason why our senses did not evolve to sense the physical reality as it is.

We will come back to the virtuality of time and space (mainly in the form of the distinction between a *sensed* reality and an *absolute* reality) again and again in the book. We will use concepts from evolutionary biology, neuroscience and, most of all, from physics to understand the unrealness and its implications. We will see interplay between modern sciences (biology, physics, neuroscience, *etc.*) and the philosophical schools of thought. We will see clearly what it means to say that reality is a representation of our sensory inputs.

If our reality is merely a representation created in our head, what is it that is being sensed? Paradoxically, the absolute, physical reality cannot be known. The sensed reality, the representation is the Unreal Universe. The distinction between the sensed reality and what is being sensed is not a new insight. Such questions about the nature of reality have been articulated and attempted in metaphysics and in many lines of Eastern philosophy. Similar inquiries into the basis of reality and knowledge are found in epistemology.

1.4 FROM PERCEPTION TO PHYSICS

What is novel in this book is the *application* of these philosophical concepts to answer some real physical questions. This book is an attempt to extrapolate from what is known into what is not knowable. We hope that the insight represented in this extrapolation will have some impact on the way in which we understand the workings of the universe, that it may take us a little closer to "God's own thoughts."

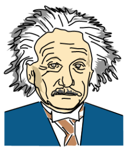
Toward the end of the book, we will see how the workings of physics, and indeed of all sciences, are inextricably intertwined with our philosophical stances on the nature of reality. Philosophy provides the ground rules and the arena where the sciences play out their games. Perhaps this line of thinking, rather than worries about its own irrelevance, is behind the maternal claim that philosophy stakes on sciences.

2

Nature of Time

The only reason for time is so that everything doesn't happen at once.

—Albert Einstein



Of the many philosophical assumptions in physics about the nature of reality, none is more mysterious than the existence of time. Time can be relatively easily discredited by imagining deserted islands or other settings devoid of conscious beings. Yet, despite the logical acceptance of the unreal nature of time, we do know that a year from now, we will be a year older. Why is it that we cannot escape the unrelenting hold of time? The reason is that the origin of time is linked to our most basic knowledge—our self-awareness, the knowledge that we exist. Before proving this assertion, let us examine some aspects of time.

2.1 SENSING TIME

Unlike space, time does not have any of our five senses assigned to it. Our primary sensory mechanism, sight, creates a 3-D world around us. Even in the absence of vision, hearing can place point sources in a 3-D space. A 3-D map of objects in our immediate vicinity can be created by our touch sense also. Time is totally different from this sense of 3-D space. We have no built-in mechanism to perceive or sense time. Despite this glaring absence, human beings do have a sense of time. Where does this sense come from? What is the origin of this sense of time that permeates all our physical sciences and plays a crucial role in every single conscious action and decision we make in our lives? To answer this question, we need to understand the notion of scale in our perception and the evolutionary process that brought about such a notion.

Millions of years of evolution ensured that our senses are best suited for our survival and reproduction. We can best sense objects and movements at scales comparable to our body dimensions and speed. We can clearly see a person running, but not a bullet coming at us, nor the movements of the hour or minute hand of a clock. We can appreciate the difference in size between an adult and a child, but not between two celestial objects or micro-organisms. This sweet spot where our senses and perceptions work best is not limited to the tangible measures such as speed and size.

Our sense of numbers is also related to human scale. Human beings are poor in assessing long odds—a fact illustrated by the thriving casinos in Las Vegas. Another example of our collective inability to assess probability is the fear of flying. Many people suffer from a fear of flying; not many suffer from a fear of crossing a street, even though, statistically, it is more dangerous to cross a street than to travel in an airplane. If we crossed a street every day, and if our average life expectancy were a million years, we would almost certainly get run over one day. But, we might still be able to fly everyday without crashing. And if we had such long lives, it would be obvious to us that crossing the street is a much more dangerous proposition than flying because we would be sensitive to such tiny probabilities and differences between them.

Here is another, more concrete example of our life expectancy modulating our risk assessment. If our life expectancy were only five years, AIDS would not be a serious illness, for our life would most likely end before AIDS could kill us. This is probably why some monkeys can be carriers of the dreadful disease without dying of it. Their life span is much too short.

Now, what does all this have to do with time? The human scale modulates our sense of time, much like it does our perception of size, speed and probability [2]. Our sense of time is modulated by our life expectancy. If we lived forever, would we have a sense of time? Let us consider the possibility that if we were immortal, we probably would not have a sense of time. Time is sensed through change. Does immortality imply a lack of change as well? It should because changes can be thought of as small deaths and rebirths. Some cells die, some others take their place; that is how a biological change takes place. The real question about the existence of time is not so much whether we would have a sense of time under the conditions of immortality, but whether there will be time at all if we are not here to sense it, or if we were all incapable of sensing time for whatever reason? The uncertainty we feel in answering these questions should point to the virtuality of time.

2.2 PHYSICS OF TIME

The whole argument on the virtuality of time boils down to this—we sense time as a fraction of our expected lifetime. If our lifetime were infinite (or if we did not know that it was finite), then all finite spans of time would be so small in comparison that we probably would not have a sense of time. If we did not have a sense of time, would that mean there was no time? Does time have an existence independent of our minds? More to our purpose in this book, would it be possible to do physics without a notion of time? Physics, as we know it today, (*e.g.*, Newton's laws of motion and the special theory of relativity) has time figuring prominently as an essential ingredient. A physics with no explicit time was attempted by Julian Barbour (in *The End of Time*), which shows that time is not essential. Time, however, makes it far more convenient to do physics.

To get to *real, physical* time from our sense of time is not a small step. Interestingly, there are two different concepts of time in physics. One is the "normal" continuous time that we have a natural sense of. The other is the malleable time that can get dilated. Let's take a closer look:

Galilean Time: In the Galilean view of space and time, the physical existence of an absolute and global time is assumed. Isaac Newton defined it as follows: "Absolute, true and mathematical time, in itself, and from its own nature, flows equally, without relation to any thing external; and by other name called Duration. Relative, apparent, and vulgar time, is some sensible and external measure of duration by motion, whether accurate or unequable, which is commonly used instead of true time; as an hour, a day, a month, a year. It may be, that there is no equable motion, whereby time may be accurately measured. All motions may be accelerated and retarded, but the flowing of absolute time is liable to no change."

In this view of time, there is no fundamental reason against superluminal (faster than light) travel. There is a notion of simultaneity. That is, if two things happened at the same instant somewhere, there would be no doubt of its happening at different instants. Your past cannot be in another's future; there is no time travel. In other words, this is our natural sense of time. However, this notion of time will not work for the special theory of relativity. But, we are getting a bit ahead of ourselves...

Minkowski Space-Time: The Minkowski view of reality is fundamentally different. In this notion of space and time, there is no absolute, global time that is physically meaningful. This notion of time is based on Albert Einstein's revolutionary paper [3] that redefined the notion of simultaneity. In a move akin to Copernicus's abandoning the notion that we were the center of the universe, Einstein decided to abandon the notion of absolute time. Instead, he postulated two principles:

1. All physical laws are immutable in all reference frames.
2. The speed of light is constant in all reference frames.

The second postulate, which is a bold assumption, redefines time. It implies, in contrast to Galilean time, that simultaneity is not an absolute physical quality, but a relative one, depending on the motion of the observer (*i.e.*, the reference frame). Mathematically, it mixes space and time.

We will get into more details of the space-time issue later on. Let's ask ourselves which one of these two notions of time is the "real" one because the Galilean time is different from the Minkowski space-time.

A physicist will tell us the Minkowski picture is a generalization of the Galilean notion of space-time. This is absolutely true, in a mathematical sense. However, we lose something in this generalization—we lose the sense of a global absolute time. Along with that, we lose our ability to say whether two events take place at the same time—simultaneity. In other words, we lose the fundamental qualities of our natural sense of time. If we are willing to sacrifice these qualities, are we also willing to forgo our natural sense of time altogether and think of it as a mathematical construct? This construct may be unnecessary for our understanding of nature and the universe.

Physics has another deep problem with time. It cannot easily explain why time has a direction—an arrow, as it were. This arrow does not present itself in the fundamental laws governing physical interactions. All the laws in physics are time reversible. The laws of gravity, electromagnetism or quantum mechanics are all invariant with respect to a time reversal. That is to say, they look the same with time going forward or backward. So they give no clue as to why we experience the arrow of time.

Yet, we know that time, as we experience it, is directional. We can remember the past, but not the future. What we do now can affect the future, but not the past. If we play a video tape backwards, the sequence of events (like broken pieces of glass coming together to for a vase) will look funny to us. However, if we taped the motion of the planets in a solar system, or the electron cloud in an atom, and played it backward to a physicist, he would not find anything funny in the sequences because the physical laws are reversible.

Physics considers the arrow of time an emergent property of statistical collections [4]. To illustrate this thermodynamic explanation of time, let's consider an empty container where we place some dry ice. After some time, we expect to see a uniform distribution of carbon dioxide gas in the container. Once spread out, we do not expect the gas in the container to coagulate into solid dry ice, no matter how long we wait. The video of CO_2 spreading uniformly in the container is a natural one. Played backward, the sequence of the CO_2 gas in the container congealing to solid dry ice in a corner would not look natural to us because it violates our sense of the arrow of time.

The apparent uniformity of CO_2 in the container is due to the statistically significant quantity of dry ice we placed there. If we manage to put a small quantity, say five molecules of CO_2, we can fully expect to see the congregation of the molecules in one location once in a while. Thus, the arrow of time manifests itself as a statistical or thermodynamic property. Although the directionality of time seems to emerge from reversible physical laws, its absence in the fundamental laws does look less than satisfactory philosophically.

2.3 PHILOSOPHY OF TIME

The existence of time (or a sense of time) has been a problem in philosophy. Let us take a quick look at time from this angle. Our treatment is a bit different from the traditional philosophy of time.[1] Here, we look at the interplay between language and time. Let's take a quick look at the philosophy of language so that we can see how time fits in it.

Some consider language the most important part of our relation with reality. Language is not merely a communication tool, but also the canvas on which our conscious existence is painted. Without a language, we may not even have conscious thoughts. We will get back to the philosophy of language a bit later and look at it in much more detail. Here, we want to understand how time figures in language.

Language has a syntax specifying the grammatical rules and semantics that give meaning. At the semantic level, there is a *reflection-correspondence theory* of language. In this theory, language can be thought of as a collection of the correspondences between words and objects in the *external reality*. If we look at any word in our language and ask ourselves what it means, we will see that it represents something in the external reality.

Language mirrors the external world. However, a little bit of thinking along this line will convince you that this definition of language,

[1] I should start this section with a disclaimer that I am approaching these issues as a physicist, not as a philosopher. For this reason, the terminology used in articulating these musings on the philosophy of time may differ from the one in traditional philosophy.

at best, is incomplete. Language has a much richer structure. There are structures in language that need explaining. *e.g.*, the word "book" represents the thing you are holding. A "small book" adds a quality to the object "book." Smallness is a physical quality, so the qualifier still has a kind of correspondence to an external physical attribute. But we can see that qualifiers are at a deeper level of hierarchy in the inner structure of language.

There are other qualifiers that fall in a different category. For instance, if we think of a "great book," the qualifier "great" is different because the quality does not correspond to a physical attribute. So this class of qualifiers is at an even deeper hierarchy. This hierarchy is where abstract nouns such as "happiness" and "wisdom" belong (along with the corresponding qualifiers).

Now, let's look at numerical qualifiers. "Two books"—the qualifier here refers to something entirely different. In fact, numbers, along with the rules (syntax), in mathematics form a kind of *formal language*. The formal language of mathematics, however, is a little weak in semantics. This weakness is the reason the efficacy of mathematics in explaining real physical phenomena never ceases to amaze. The same weakness puts the entire formal language of mathematics roughly at the same hierarchal level as abstract qualifiers such as great, happy, wise and so on. Thus, although "two books" means something easily understandable, "two" by itself is an abstraction. The semantic weakness disappears when mathematics is used in physics. Physics provides the meaning.

Like mathematics, time can be thought of as a formal language. The syntax of time is not as rich as the one in mathematics, but semantically, time is much stronger. Unlike mathematics, its meaning is not as open to interpretation. Time can be considered an abstract formal language embedded in almost all languages in the world. Where exactly do we embed time in our languages? Its position is at least as deep as that of mathematics, probably deeper. Even the syntax of the formal language of time is defined in abstract terms such as past, present and future, along with a concept of its flow and direction.

Thinking of time in terms of the philosophy of language serves only one purpose. It illustrates the virtual nature of time, much like that of mathematics. Mathematics gets its semantics mostly from physics; time, on the other hand, derives its meaning indirectly from our knowledge of our demise. Although we cannot directly test this conjecture, we can consider a few thought exercises that may shed some light on the issue.

1. Do animals have a sense of time? It is unlikely that they are conscious of their death. So, by our conjecture, they should not have a sense of time.

2. If you grew up on an island, without contact with other human beings, would you have a sense of time? It seems obvious that you would not have a language in the conventional sense of the word. Some philosophers believe that you would not even have any thoughts at all. But does the sense of time come *before* or *after* thoughts?

3. Is it possible that our sense of time changes as we grow older? Don't we feel as though years are getting shorter and shorter as we grow older? Is it possible that our sense of time is related, not only to the knowledge of our demise, but also to our sense of how long we have left to live?[2]

2.4 HISTORY OF THE UNIVERSE

We argued that our sense of time was modulated by the natural scale involved—our life span. This is why we are not able to appreciate the huge difference between large time scales, such as the difference between the time dinosaurs went extinct and when human beings evolved. One way of appreciating it would be to "translate" or map these cosmological or evolutionary time scales to a human scale. Table 2.1 is one such mapping.

Here, we think of the universe as a forty-five year old. Thus, the current estimate of the age of the universe (about fifteen billion years) maps to forty-five years. The early years of the universe are fuzzy, much like our memories of our childhood. Most of the prime years of the universe were spent on building a universe worthy of hosting

[2] I realize that the question is a little cyclic because it defines our sense of time in terms of our sense of the duration we have left to live, which serves to show how deeply time is embedded in our mode of thinking.

Table 2.1 A time-line of the significant events in the life of the universe. The first column is the "time", presented as though the universe is forty-five years old now. The second column is the event that took place at that time. The last column is when it happened, in real time.

Time mapped to 45 years	Event	Real Age
	Cosmological Era	
45 years ago	The universe is born.	15 Billion years ago
39 years ago	Clusters of galaxies begin to form.	12 Billion years ago
36 years old	Milky way forms.	11 Billion years ago
14 years ago	Solar system forms. Disc planets.	4.7 Billion years ago
12 years ago	Earth forms, with liquid water and rain. Origin of organic material.	4 Billion years ago
	Evolutionary Era	
11.5 years ago	Cells form.	3.9 Billion years ago
11 years ago	Bacterial life, spores.	3.5 Billion years ago
3 years ago	Colony of algae, hormones and fungi.	1 Billion years ago
2 years ago	Jelly fish.	650 Million years ago
20 months ago	Flat worms, animal groups.	570 Million years ago
29 months ago	Vertebrates.	500 Million years ago
14 months ago	Sharks, finned fish, insects.	390 Million years ago
12 months ago	Ferns, invertebrates, amphibians.	350 Million years ago
9 months ago	Dinosaurs.	250 Million years ago
7 months ago	Mammals.	200 Million years ago

23 weeks ago	Birds.	150 Million years ago
70 days ago	End of dinosaurs.	65 Million years ago
55 days ago	Spread of mammals.	50 Million years ago
44 days ago	Cow family.	40 Million years ago
	Human Era	
3.3 days ago	Recent ice age. Homo erectus.	3 Million years ago
18 hours ago	Fire.	700 thousand years ago
5 hr 15 min ago	Neanderthals.	200 thousand years ago
2 hr 38 min ago	Humans.	100 thousand years ago
17 min 20 sec ago	Nomads and farmers.	11 thousand years ago
9 min 28 sec ago	Cities.	6 thousand years ago
4 min 44 sec ago	Iron.	3 thousand years ago
3 min 9 sec ago	Christianity.	2000 years ago
2 min 12 sec ago	Islam.	1400 years ago
	Scientific Era	
43 sec ago	Copernicus.	450 years ago
33 sec ago	Birth of Sciences.	350 years ago
9 sec ago	Special theory of relativity.	100 years ago
5 sec ago	Nuclear energy, quantum mechanics.	60 years ago

life. The first event of our direct interest took place about fourteen years ago—the birth of our blue green planet. These early years can be called the cosmological era. The estimate of these time scales in this cosmological era is mostly theoretical or phenomenological.

We then move on to the evolutionary time scale, from about twelve years ago to less than a week ago. Life on earth developed during these twelve years. We have a better estimate of the time scales in the evolutionary era because of radiometric dating.[3] The first semblance of human-like primates appeared about three days ago, heralding the human era.

But in any real sense, our reign on this planet began only today, within the last eighteen hours or so. We began forming villages and building cities only ten to twenty minutes ago. We began subdividing humanity in the name of God and religion about five minutes ago. We invented the pride and joy of our global civilization, the modern sciences, less than a minute ago. Our most influential theories and technologies are about ten seconds old! Even this table mapping forty-five years of our cosmic existence is based on an insight about nine seconds old. And I am typing this using a technology barely a second old!

Our reign on this planet looks set to continue for the foreseeable future—which is about twenty years when our sun will expand into a red giant[4] and life as we know it will come to an end. At least, so says the modern cosmology, which is about five seconds old!

Amusing as this thought exercise is, it has a much deeper point hiding beneath the surface. Certain theories in modern physics are extrapolations from a limited experience (or knowledge) to immense time scales. The big bang theory is an extrapolation of our insights in the last ten or so *seconds* to about 45 years. Should we really limit our quest for knowledge to the bounds of such incredibly large extrapolations? Richard Feynman's words [5] seem appropriate here: "We are only at the beginning of the development of the human race; of the development of the human mind, of intelligent life—we have years and years in the future. It is our responsibility not to give the answer today as to what it is all about, to drive everybody down in

[3] Carbon dating works for fossils from living organisms, and is good for about 50 000 years, though it may work up to 100 000 years. Other dating techniques can estimate the age of the rock that hosts fossils. The Potassium/Argon method is good for up to 4 million years, and the Rubidium/Strontium method can be used for up to 90 million years. Beyond that, the Uranium/Lead technique can be used.

[4] See the life-cycle of a typical star in §6.3.2, page 95.

that direction and to say: 'This is a solution to it all.' Because we will be chained then to the limits of our present imagination."

2.5 UNREAL TIME

Time does not exist the same way a physical object exists. In other words, time is a secondary sense without any direct sensory percept or reason for its existence. Does this mean that time is useless? Far from it. Mathematics is unreal the same way time is unreal, in the sense that it is a creation of our intellect, without corresponding to anything real. But it is supremely useful in our physical sciences. So is time. The true nature of time is something to be kept in mind in understanding its place in the foundations of physics. For instance, one way of looking at the time dilation in the special theory of relativity is to understand that time is merely a matter of definition. If time is a creation of our intellect, its measurement is open to interpretation—this is one reason why Einstein [3] could easily redefine the meaning of simultaneity.

Along with the notion of time come other intertwined concepts. One such concept is motion. Perception of motion is known in neuroscience to be an artifact created in a specific location of our brain. This fact was proven by the loss of the sense of motion as a result of a specific, localized brain lesion. Sensing motion is a mechanism that enhances our chance of survival. It is also connected with the indirect sense of time.

Causality is another fundamental concept that is intertwined with the flow of time. The reason special relativity does not permit faster-than-light travel is that such superluminal travel will break causality. In a universe where time is unreal, is causality real?

If time is unreal, why don't we feel it that way? The most likely reason is that we accept time before we learn to question it. A lot of the things that we accept before we are able to question them are difficult to relinquish (*e.g.*, concepts of God and religion). Looking at "time" as a formal language and according it a proper place in the hierarchy of our knowledge system may bring some benefits in the form of a more objective understanding of the world and reality.

Chapter Summaries

The Unreal Universe is organized in four parts. The first part looks at our notions of time and space using interesting examples from neuroscience and physics. Moving on to the philosophy of reality, it briefly discusses the Zen and Hindu lines of thinking and shows how their view is mirrored in modern sciences. The second part examines the interplay between reality and physics. It starts with a conceptual recap of modern physics and answers the question why light is so important in our space and time. The concluding third part summarizes the various ideas presented in the book. It winds up with a collection of interesting tidbits about physics, philosophy, evolutionary biology and neuroscience, which may inspire the reader to think further along the general theme of the book—accepting no assumptions without questioning, and doubting everything, including reality. The fourth part is an appendix where the ideas in the third part are presented with technical details. The chapters in the four parts are briefly described below.

Part I Perception and Reality

According to cognitive neuroscience, our perceptual experience of reality is only a distant and convenient mapping of our sensory inputs. Sound is a mapping of auditory inputs, and space is a representation of visual inputs. How space and time are "unreal" from this point of view is the subject matter of the first part of the book. It examines the unrealness of reality and looks at the philosophical basis of physics and knowledge. The most important message of this part is how the modern scientific realization of the nature of reality as a representation of our sensory inputs was known for thousands of years in philosophy. This interplay between ancient philosophy and modern neuroscience is further highlighted in the chapters examining the ingredients that make up reality.

1. **Mother of Sciences**
   In the opening chapter, the philosophical foundations to our knowledge are introduced. These foundations are assumptions in most cases. Some of the assumptions, especially the ones in physics, are not difficult to spot. Others that pertain to the nature of reality itself are far trickier to appreciate. These elusive assumptions include the existence of time and space, for instance. The realness of reality is not merely a philosophical issue; it is a subject matter of cognitive neuroscience as well. Once the issue of reality gets back to the realm of science, it becomes something that physics has to describe. Physics, in turn, is erected on the philosophical assumptions on the existence of time and space. This overlap among seemingly distinct domains is reflected in the chapter flow of the book.
2. **Nature of Time**
   We can logically accept the virtual nature of time because we have no direct sensory mechanism to sense or perceive it. Despite this glaring absence, we do have a strong sense of time that plays a crucial role in every conscious decision we make in our lives. In this chapter, we argue that the reason for the existence of time is our knowledge of our finite life-span. We illustrate this argument by mapping the history of the universe to forty-five years. This mapping also shows how our physics of the universe is an ambitious extrapolation from a very short span of knowledge to incredibly long time scales. Physics has multiple notions of time—Newton's constant time and Einstein's malleable time. The difference between these notions of time is indicative of its unreal nature. Time is unreal the same way as mathematics is unreal; they are both products of our intellect. And philosophically, they can both be thought of as formal languages.
3. **Unreal Space**
   Unlike time, space does have a sensory correlate. Our perception of space is the end-result of our most precious sense, namely sight. For this reason, the unreal nature of space is not as obvious as that of time. In this chapter, we take a quick look at how sight works from the perspective of neuroscience. In particular, we study the cases where tiny physiological defects manifest themselves as drastic disorders in visual perception. How sight creates space is analogous to how hearing creates sound. Sound is not the intrinsic property of a vibrating body, but our cognitive representation of the air pressure waves our ears sense. In an exact parallel, space is our visual reality, or the cognitive representation of the light inputs to our eyes. It is no more real than sound or smell. Or time.
4. **Pillars of Reality**
   Discussing the nature of reality has the curious effect of casting doubt on its realness. In this chapter, we look at the many pillars on which reality rests. Our senses provide the inputs to the brain, which creates a cognitive model that we think of as reality. The cognitive model heavily depends on

the other "software" running on the brain, namely consciousness, language and memory. In the absence of consciousness, reality has little significance. Similarly, if the brain does not have a language apparatus to process thoughts, reality cannot be created. Memory is the last essential support to our sense of reality. What does it mean to say something happened if nobody can remember it? An interesting and important aspect of the brain is that it always tries to create a reality that best fits the sensory inputs, resolving any possible sensory conflicts.

5. **Philosophy of Reality**
   The suspicion, or the conviction, that reality is not all that real existed in some branches of philosophy, both Western and Eastern. In this chapter, we take a quick look at these philosophies. The Indian and the Zen spiritual lines of philosophy view our senses and mind as actual impediments to an intuitive understanding of the absolute reality behind our experiences. Western philosophy, on the other hand, treats the nature of reality and knowledge as the formal lines of metaphysics and epistemology. Western philosophy also provides the basis of scientific realism in modern physics.

Part II Reality and Physics

The physics part of the book starts with a conceptual description of three aspects of modern physics, the special theory of relativity, particle physics and cosmology. Looking at reality as a cognitive model distorted by the finite speed of light yields a compellingly simple understanding of the special theory of relativity. It also provides simple explanations for a host of astrophysical and cosmological phenomena at vastly different time and length scales. All these explanations are presented in this part with no mathematics or technical details, but with the help of numerous diagrams and examples.

6. **Physics Primer**
   In this first chapter on physics, we look at three branches of modern physics. These are (1) the special theory of relativity dealing with objects at high speeds, (2) particle physics dealing with very small length scales and (3) cosmology and astrophysics, dealing with various phenomena in our universe. The common thread binding these different branches is that they all deal with physics beyond the ranges of our senses. Extrapolating physics from our reality to what lies beyond our senses involves deep philosophical assumptions. This chapter uncovers the philosophical basis of modern physics. It shows how scientific realism is the philosophical stance adopted in modern physics and how another stance is possible. This new stance is based on the notion from neuroscience that our reality is our brain's creation, almost identical to the Zen and Hindu view of the world.

7. **Why the Speed of Light?**
   Once we adopt the philosophical stance of reality as our brain's creation, we can understand why the speed of light figures so prominently in our physical theories. The theories of physics are a description of reality.

Reality is created out of the readings from our senses. Our senses all work at the speed of light. Thus the sanctity accorded to the speed of light is a feature only of *our* reality, not the absolute, ultimate reality which our senses are striving to perceive.

8. **Perception and Special Relativity**
   In this chapter, we look at our perception of moving objects. First, we look at echolocation as an "inferior" sense modality operating at a slower speed. This study will show how the speed of the sense modality influences the perception of motion. From this understanding, we will see that all the strange effects of the coordinate transformation in special relativity can be understood as the manifestations of the finite speed of our senses in our space and time. When it comes to the phenomena that happen well beyond our sensory ranges, we really have to take into account the role that our perception and cognition play in seeing them. The universe as we see it is only a cognitive model created out of the photons falling on our retina or on the photo-sensors of the Hubble telescope. Because of the finite speed of the information carrier (namely photons), our perception is distorted in such a way as to give us the impression that space and time obey special relativity. They do, but space and time are not the absolute reality. They are only a part of the unreal universe that is our perception of an unknowable reality.
9. **Beyond Special Relativity...**
   After showing that special relativity applies to the cognitive model created by the brain, we will ponder over the physical causes behind the model, the absolute reality itself. It may be possible to guess the nature of the absolute reality and work out how we would perceive it. We will show how this line of thinking explains certain phenomena that have been puzzling scientists for a while. These phenomena include symmetric radio jets and gamma ray bursts from astrophysics. We also end up with a conceptually elegant resolution of the twin paradox and the issue of causality violation in superluminal motion.

Part III Summing Up...

After summarizing the various ideas presented so far, the book winds up with a collection of possibly unrelated, but interesting, thoughts. They are presented as a kind of intellectual dessert, which may inspire further thinking.

10. **Last Words**
    Summarizing the thoughts presented in the book, we highlight how the nature of the absolute reality is really beyond our grasp and that the choice of accepting the perception of reality as a true image of reality is indeed a philosophical stance. The alternative presented in the book, namely guessing the nature of the absolute reality and comparing its predicted projection to our real perception, may simplify and elucidate some theories in physics and explain some puzzling phenomena. However, this option is

just another philosophical stance against the unknowable absolute reality. We also show how different levels of possibly conflicting views of reality may coexist in our minds, giving us physical theories that are in conflict with each other. General relativity and quantum mechanics are examples of such conflicting theories, which are descriptions of realities beyond *different* limits of our senses. Due to this difference in their origin, their unification may prove impossible, unless we are willing to tolerate more arbitrary assumptions and complex mathematics.

11. **Random Thoughts**
In this concluding chapter, the reader is presented with a bunch of interesting thought exercises. It includes a game where the book tries to predict the level of reader's faith in a supreme being by testing how left or right-brained the reader is. It also mulls over such desultory topics as the universality of mathematics, the logic of evolution, the nature of gravity, and the shape of Yin and Yang. How every conscious being is at the center of the universe, its own personal unreal universe, is another piece of ancient wisdom that our sciences are now converging to. The book concludes with a discussion on how the concept of God is not in conflict with physics, for there is plenty of room beyond the limits of our knowledge for a plausible God.

Part IV Appendix—Physics Details

This appendix of the book gives technical details of the conceptual picture drawn in the preceding parts. This is the only part of the book that has equations. The equations and their derivation substantiate the claims made earlier and illustrated textually using examples. In addition to the mathematical details, this part also includes a chapter on the future directions and projects that may be taken up by the author or other scientists.

A **Perceptual Relativity**
In this chapter, we compare special relativity to the so-called light travel time effect. This is mathematically rigorous description of the previous chapter, "Perception and Special Relativity." The overlap between the chapters, however, is kept to a minimum by using many examples and a different, more technical level of presentation. This chapter also presents two cosmological features of our observed universe that can be understood in terms of the light travel time effects. These features are the apparent expansion of the universe and the cosmic microwave background radiation.

B **Unreal Astrophysics**
Here we present a unified kinematical model for double-lobed symmetric radio sources and gamma ray bursts in the light of how we perceive motion. Gamma ray bursts can be viewed as an effect similar to the sonic boom in supersonic motion. The auditory world has another effect analogous to the radio sources. The model will show how these two phenomena are related. All the technical details of the model and comparisons between its predictions and observations are presented. The mathematical details are

moved to a chapter appendix so that the main body of the chapter can be read without distractions.

C **Future Work**

The chapter on possible future projects is a challenge to any reader who may want to pursue our line of thinking. These are also projects that the author himself may take up either as thought exercises or future books, circumstances permitting. The projects listed are:

(a) Simulation of the observed redshift

(b) Celestial velocity distribution that explains the observed cosmic microwave background radiation (CMBR)

(c) Similarities between black holes and superluminal explosions

(d) Alternate explanations of Michelson-Morley Experiment

(e) Quasi-linear formulation of the light travel time effects

(f) Treating the covariance of MaxwellŠs equations

(g) Integration of special relativity in general relativity

(h) Determination of the dimensionality of “space” in the absolute reality

Glossary

The symbols, terms and abbreviations most commonly used in this book are described below for easy reference. Also see §5.3.2 (page 67) and §6.3.3 (page 95) for lists of specialized terms from Indian philosophy and modern cosmology respectively.

Terms and Abbreviations

AGN Active Galactic Nuclei. AGNs are galaxies that seem to spew massive amounts of energy from their centers, far more than ordinary galaxies. They are believed to have super-massive black holes at their center powering their explosive energy output.

Black Body Black body is a hypothetical, perfect radiator, radiating EM spectra of all frequencies. It generates an emission spectrum determined only by its temperature.

CMBR Cosmic Microwave Background Radiation. The near uniform background radiation from all directions in the sky. CMBR is considered a proof positive for the Big Bang theory of the origin of the universe.

Doppler Shift The Doppler Shift is the frequency variation (both in sound and light) due to the motion of either the observer or the source. The Doppler shift is the reason the pitch of the ambulance siren changes as it passes us.

DRAGN Double Radio source Associated with Galactic Nucleus. DRAGNs are described as plasma clouds that have been shot out of active galactic nuclei (AGN) via narrow jets. They emit radiation mainly in the radio frequency (RF) range of the electromagnetic (EM) spectrum.

EM Electromagnetic, as in electromagnetic interactions and electromagnetic spectrum.

GRB Gamma Ray Burst. The short, intense flashes of γ rays in the sky, lasting from a few milliseconds to several minutes. They occur at random points in the sky at cosmological distances. They emit intense γ rays for a brief period. rays. GRBs are considered signatures of cataclysmic events such as supernovae.

LT Light Travel Time. The fact that light takes a finite time to reach us from distant objects like stars and galaxies. The LT effects cause distortions in our perception of motion. For instance, an object coming toward us at a shallow angle will appear to be coming in much faster than its real speed.

Microwave The part of the EM spectrum with frequencies above RF, from 1GHz to 300GHz. GRBs and DRAGNs have emission in microwave region also.

MMX Michelson-Morely Experiment. An experiment that tried to measure the effect of motion on the speed of light and is thought to have found none.

Photon Light particle. Because of the wave-particle duality in quantum mechanics, light can be thought of as waves or particles. When light is considered a particle, it is called a photon. It is a quantum of light.

RF Radio Frequency. The part of the EM spectrum that is usually used for communication. The frequency range of the RF waves is between 3Hz and 3GHz. DRAGNs emit significant energy in the RF region.

Redshift When the objects are receding from the observer, the light emitted gets stretched and its frequency shifts to lower values (towards red for visible light) because of the Doppler shift. By measuring the redshift (z), one can estimate the recession speed.

Scientific Realism A philosophical school of thought that accepts the constructs of science (such as atoms, fields, quarks, wave functions, *etc.*) as part of reality. Scientific realism implies that the way we perceive reality is a very good approximation of the underlying physical reality and that we can get arbitrarily close to the physical reality as our observational and measurement technologies evolve.

SR Special Relativity or the special theory of relativity. Einstein introduced SR in his famous paper of 1905 postulating that only relative motion has physical significance and that the speed of light as measured by all moving frames of reference has to be a constant.

Units of Measure

Hz Measures frequency. It is defined as the number of cycles per second.

K Kelvin. A measure of temperature. Zero K is considered the "absolute zero" because all atomic motions are expected to stop at 0K.

Lightyear A measure of distance (not time). A lightyear is the distance that light travels in empty space during one year. It is about 9.4 trillion kilometers or about 5.9 trillion miles.

mas/year Milliarc-second per year. A measure of angular speed of celestial objects. An arc-second is a sixtieth of one arc-minute, which is a sixtieth of one degree. One arc-second = 0.0001167 degrees, and one milliarc-second is about a millionth of a tenth of a degree.

m/s Meters per second. A measure of speed. Light travels at 3×10^8 m/s.

Greek Letters and Symbols

c The speed of light.

β Velocity or speed ratio in SR (typically a scalar, even though velocity is a vector). When an object is moving with a velocity of v, $\beta = v/c$. In some calculations, physicists simplify the algebra by choosing the units such that $c = 1$, in which case β is the speed of the object.

γ Gamma rays are the part of the EM spectrum of extremely high energies. If a black body emits radiation in the γ region, its temperature has to be extremely high.

∞ Infinity. A number that is larger than all possible or conceivable numbers. In SR, c plays the role of an infinitely large speed.

z Symbol for redshift. (See Redshift above)

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Further Reading

The interplay between philosophy and science is the subject matter of several books. Here is a list of some well-known books that influenced my work and inspired my thinking. Some of them may be considered competition to my book, although their subject matter and approach differ from mine. To the best of my knowledge, there is no other book dealing with the central theme of *The Unreal Universe*, namely, identifying and removing the perceptual limitations in the theories of physics based on a philosophical or spiritual notion of reality and knowledge.

The Tao of Physics looks at the similarities between the Eastern philosophy and modern physics, mainly from the point of view of the unity or indivisibility of the system and the observer as implied in quantum mechanics. Unlike *The Tao of Physics*, my book looks at the notions of space and time in special relativity. The starting point of the analysis in my book is the notion of reality is a conceptual model of sensory inputs, which *The Tao of Physics* touches upon. However, the theme of my book is an attempt to apply this insight in understanding both physics and philosophy.

Full Title:	*The Tao of Physics: An Exploration of the Parallels between Modern Physics and Eastern Mysticism*
Author:	Fritjof Capra
ISBN:	1570625190
Publisher:	Shambhala; 4th edition (Jan. 2000)
First published:	1975
Pages:	366
List Price:	$15.95

The End of Time develops physics without the notion of time. It argues that time is sensed only through change, and uses a collection of "Nows" to do physics. The virtual nature of time is highlighted in my book as well, but from a different perspective of evolutionary biology. *The Unreal Universe* concentrates on perceptual effects in sensing motion and space.

Full Title:	*The End of Time: The Next Revolution in Physics*
Author:	Julian Barbour
ISBN:	0195145925
Publisher:	Oxford University Press (Oct. 2001)
Pages:	384
List Price:	$17.95

Catching the light is a remarkably insightful book on the role of light in our lives. It is an almost lyrical study of the history and science of light. *The Unreal Universe* also highlights the role of light in creating our reality, but my book takes the notion much farther an explores the manifestations of light-based perception in both science and philosophy.

Full Title:	*Catching the Light: The Entwined History of Light and Mind*
Author:	Arthur Zajonc

ISBN:	0195095758
Publisher:	Oxford University Press (Apr. 1995)
Pages:	400
List Price:	$18.95

Impossibility looks at the limits of what is knowable, the finite speed of light being one limit. My book shows how knowledge beyond this limit is attainable, and how it can be applied in understanding the theories of physics as well as spiritual writings.

Full Title:	*Impossibility: The Limits of Science and the Science of Limits*
Author:	John D. Barrow
ISBN:	0195130820
Publisher:	Oxford University Press (Dec. 1999)
Pages:	296
List Price:	$18.95

What Makes You Tick? is a physiological exploration of the building blocks of our sense of reality. Concentrating on visual perception and how it becomes our reality, this book provides numerous examples. Some of these examples (split-brain patients, for instance) are referred to in my book. However, it is only the initial part of my book that deals with the physiology of sensing; the latter part is about the role of perception in science. Despite this difference in the subject matter, my book targets the same readership, using the same level of presentation.

Full Title:	*What Makes You Tick? The Brain in Plain English*
Author:	Thomas B. Czerner
ISBN:	0471209902
Publisher:	Wiley, New Edition (Jan. 2002)
Pages:	240
List Price:	$15.95

The Conscious Mind deals with the difficult problem of consciousness mostly from a philosophical and logical perspective. One of the most striking notions in this book (which I referred to in mine) is the notion of the "explanatory irrelevance." Explanations based on physical processes are not nearly enough to comprehend consciousness, or life. Even after explaining all the physical processes behind brain functions, one might still ask, "Sure, but why should that lead to consciousness?" Chalmers illustrates this paradox using a zombie twin paradigm, who has all the necessary physical processes, but no consciousness. My book does touch upon consciousness as a necessary ingredient in creating our sense of reality, but my subject matter is the role of sensing in science.

Full Title:	*The Conscious Mind: In Search of a Fundamental Theory*
Author:	David J. Chalmers
ISBN:	0195117891

Publisher:	Oxford University Press (Oct. 1997)
Pages:	432
List Price:	$19.95

A Cognitive Theory of Consciousness seeks to develop a formal theory of consciousness. Consciousness is an essential ingredient in our sense of reality, but it is not the focus of attention in my book. One specific aspect of how consciousness shapes reality, what the author calls "the context of conceptual thought," is referred to in my book.

Full Title:	*A Cognitive Theory of Consciousness*
Author:	Bernard J. Baars
ISBN:	0521427436
Publisher:	Cambridge University Press (Jul. 1993)
Pages:	448
List Price:	$48.00

The Blind Watchmaker by Dawkins is one of the most readable books on evolutionary biology. Some parts of my book (the notion of scale in perception, for instance) are inspired by this book. Dawkins describes echolocation with exceptional insight and clarity. Echolocation is made use of in my book, but with a different purpose of illustrating the limitations of perception.

Full Title:	*The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe Without Design*
Author:	Richard Dawkins
ISBN:	0393315703
Publisher:	W. W. Norton & Company (Sept. 1996)
First published:	1986
Pages:	358
List Price:	$16.95

Physics of the Soul is an attempt understand the Hindu spiritual views in terms of quantum mechanics. *The Unreal Universe*, on the other hand, attempts to understand special relativity using the Eastern views.

Full Title:	*Physics of the Soul: The Quantum Book of Living, Dying, Reincarnation and Immortality*
Author:	Amit Goswami
ISBN:	1571743324
Publisher:	Hampton Roads Publishing Company (Sept. 2001)
Pages:	289
List Price:	$16.95

Other Resources

In addition to the books listed above, several other resources have inspired or influenced my book. Here is a partial list:

The Emerging Mind: Reith Lectures on Neuroscience (BBC Radio, 2003) given by V. S. Ramachandran, the director of the Center for Brain and Cognition, San Diego, CA, USA. My book refers to several examples of physiological brain anomalies and their perceptual manifestation from this lecture series.

Brain Story: BBC documentary program on brain. Neuroscientist Prof. Greenfield (the director of the Royal Institution and professor of pharmacology at Oxford University) gives a personal view of what it is about our brains that makes us think, act and feel the way we do. My book refers to some examples of brain damage and consequent alterations of sensed reality from this program as well.

No Ordinary Genius: BBC documentary program on Richard Feynman. In this program, Feynman explains the difference between knowing the name of something and knowing something, which is quoted in my book. He also describes a hypothetical, tiny creature in a corner of a swimming pool sensing the waves and inferring the state of the whole pool. He then compares this picture to human vision and our perception of the universe. Although not quoted in the book, this analogy definitely inspired some of my thinking.

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Index

The index contains <u>underlined</u> and **bold** page numbers against the indexed terms. <u>Underlined</u> numbers refer to pages where the terms are defined or explained in detail. **Bold** numbers refer to pages where the terms are described with technical details.

H

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"A book for thinking laymen, this readable, thought-provoking work offers a new perspective on our definition of reality."

—Bobbie Christmas, Book Doctor, Zebra Communications

"Well written, very clear to follow for the nonspecialist."

—Wendy Lochner, Senior Editor, Columbia University Press

In this immensely thought-provoking book, Thulasidas attacks our notions of space and time and shows how our sense of reality rests on uncertain supports. Space is unreal the same way sound and smell are unreal, and time is no more real than mathematics. In a space created by the brain out of the light falling on our retinas (or the Hubble telescope), is it a surprise that nothing can travel faster than light? Generated by our sensory perception and fabricated by our cognitive process, the space-time continuum is the arena of physics. Looking at reality as a cognitive model of perception, Thulasidas sheds light on spiritual philosophies, both Western and Eastern.

Exploring the overlaps among the sciences and philosophies with impressive surety and clarity, *The Unreal Universe* promises to revolutionize the way we think of reality and understand both modern physics and ancient spiritual writings.

"This work should be required reading to anyone embarking on a new scientific journey."

—Steven Bryant, Vice President, Primitive Logic

Manoj Thulasidas is an experimental physicist who worked at CLEO and CERN for over ten years. In the last few years, Thulasidas has been interested in the workings of the brain, focusing his attention on Brain Machine Interface and neural signal acquisition and processing. *The Unreal Universe* is in part the outcome of the insights gained during his professional research career, in addition to his philosophical bend of mind.

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