Physics Reforged:
The New Theory of Parallel Universes, Hidden Dimensions, and the Fringes of Reality

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This text constitutes the work of Julian von Abele.

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Dedication

To the great physicists of yesteryear, who have expanded our understanding of the cosmos; for today we stand upon the shoulders of giants

Contents

Note to the Reader:

This text describes the remarkable story of *QCI Theory* (quantum complintegrodynamics), a novel idea in particle physics which suggests that we live in one of many universes. As a book designed for a layperson audience, the present text assumes only an elementary background in high-school science and basic algebra. A more sophisticated study is provided under Appendix I, for the professional physicist.

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Part I:
An Unknown Cosmos

1. An Unknown Cosmos

"Nature uses only the longest threads to weave her patterns, so that each small piece of her fabric reveals the organization of the entire tapestry"

– Richard Feynman

Of all the remarkable tales within the Arabian Nights, "The Adventures of Bulukiya" exhibits the most striking resemblance to modern science-fiction, having been composed first during the height of the Sassanid Empire and translated into Arabic during the Abbasid Caliphate. It tells the story of Bulukiya's quest to achieve immortality, and his fascinating encounters with talking serpents, societies of Jinns, and distant lands during his voyage. Distinguishing this story from the rest of the Nights, however, is its unique focus on the existence of other worlds, alternate planes of existence with magical beings and fantastical intrigue. Bulukiya discovers the existence of other universes, parallel realities similar to, but distinct from, our own, and his travels through this vast cosmos resemble similar themes in contemporary galactic fiction, fantasy, and space opera. Indeed, it is telling that the Arabian Nights had such a broad influence on the development of literature during Europe's eighteenth century. Perhaps the seeds of fantastical literature today were planted, partly, by Arabian civilization.

The notion of *parallel universes*, other domains of reality ruled by different laws of nature, has always fascinated the intellect, and this concept has been expressed in the religious and literary traditions of innumerable cultures. Perhaps even our primordial ancestors wondered whether the stars in the sky were the campfires of other worlds. Surprisingly, however, investigation into particle physics has also suggested that our universe, our physical reality, is merely one among many. Numerous universes might populate a vast *"multiverse,"* a cosmos colossal beyond measure. Everything we can see would merely be one facet of a far broader reality. Intriguingly, analysis of different domains of theoretical physics, including cosmology, string theory, and quantum mechanics, has converged upon this common notion. This book describes the tale of one such theory: the *QCI hypothesis*. A generalization of the fundamental laws of particle physics, QCI predicts the existence of a vast number of parallel realities ruled by alien forms of physics.

In some of these realities, matter and energy disappear, leaving behind a barren void. In others, the foundational structure of electromagnetism is entirely different. Our cosmos would merely be one component of a multiverse beyond imagination. It is my hope that this hypothetical exploration of alternate universes, of other worlds, will be a rewarding investigation of physics and math, and allow any reader to come away with a refined perspective on reality.

The Physics of Other Universes

The *laws of physics* are the fundamental principles which govern the behavior of matter and energy throughout the cosmos. Although their incarnation in the context of modern physics may be complex, the idea is simple enough: even as children, we recognize that certain basic patterns repeat themselves consistently. The sun rises in the morning and sets in the evening; objects that are thrown, fall; light is distorted by water. The edifice of mathematics serves to structure these patterns into a few consistent principles. As early as the nineteenth century, the laws of Newtonian mechanics and electromagnetism predicted many subtle aspects of the world from a simple foundation. Indeed, it would be uncontroversial to suggest that our understanding of the laws of physics is central to our technological success as a civilization.

A notion, however, that has fascinated many a physicist since the dawn of modern science, is that these fundamental laws might be different in distant regions of the cosmos. Perhaps parallel realities co-exist with ours, where the laws of physics are slightly different, where gravitation behaves in a slightly different manner or the equations of quantum mechanics are distinct. In the 1980s, physicist Steven Weinberg considered generalizing the equations of general relativity, the theory describing gravity, by adding a *"cosmological constant."* He suggested that each new equation applied to a different universe, and discovered that only a small cosmological constant would allow for the evolution of intelligent life. Since then, researchers working in string theory (a theory purporting to connect general relativity with quantum mechanics) have conjectured that a vast landscape of universes might exist with different structures of space and time.

QCI Theory is a unique combination of the equations of *quantum physics* (which describes the behavior of subatomic particles) and *imaginary numbers* (or “numbers” which appear outside the usual number line). Intriguingly, this combination suggests the existence of an infinity of different universes, corresponding to different versions of quantum theory. In most of these universes, matter and energy would disappear, leaving behind lifeless, barren voids—but some would have the capacity to harbor life. The essential idea is remarkable: different laws of physics, emerging from a mathematical generalization of particle theory, correspond to other universes.

These ideas may sound confusing at the present moment. However, it is my goal in writing this book to elucidate this theory for a lay audience. Hopefully, a careful reader may come away with a truly revised notion of the nature of the universe, and even some conception of the mathematics of this theory. All that will be assumed is a basic knowledge of high-school-level science and some elementary algebra; with this background, the book should offer a unique story at the intersection of science, math, and philosophy.

Quantum Theory

Quantum theory, also known as quantum mechanics, or quantum physics, is the field of science which describes the behavior of microscopic (often subatomic) particles. One of the most groundbreaking insights of twentieth-century physics is that microscopic particles follow entirely different laws of physics than macroscopic objects. Unlike billiard balls or airplanes, that follow Newton's mechanical laws, subatomic particles can, in a well-defined sense, be in two places at once, be connected across vast distances, or exist in a combination of distinct physical states.

While the classical laws of physics, as prescribed by Newton and Maxwell, can predict exactly how physical objects will behave, the laws of quantum theory involve *probability* and *chance* at their heart. The behavior of a quantum particle can never be predicted with absolute accuracy; physicists can only determine the *probability* that a quantum system will behave in a particular manner. Thus, the notion of uncertainty is embedded in the very foundation of quantum physics. Although these ideas may seem erudite, quantum theory is at the foundation of modern electronics, used in virtually every computer, laser system, and transistor ever produced.

Newton's laws may be viewed as an *approximation* of quantum mechanics. The laws of quantum theory, when applied to macroscopic systems, approach classical physics—that is, the probability that a system will deviate from classical behavior decreases as the size increases. There are notable exceptions to this principle—and some researchers are hard at work in the attempt to produce quantum behavior in macroscopic objects—but for the most part, classical physics offers a useful approximation on large scales. Thus, the classical laws of physics and quantum theory are not inconsistent—Newtonian mechanics is a *special case* of quantum theory for large systems. Nonetheless, the bizarre and seemingly paradoxical nature of subatomic particles calls into question our very understanding of the universe.

This fascinating subject will be the center of the succeeding chapter. Then, we shall discover that the fundamental equation of quantum theory — the *Schrodinger Equation* — predicts mathematically the probabilities that a quantum particle will behave in a particular way. As such, this equation is front-and-center in standard quantum theory: it is a fundamental law of physics delineating the dynamics of quantum systems. QCI Theory generalizes this equation to a new realm: that of *imaginary numbers*. The result is an infinity of new laws of physics, corresponding to how this equation is generalized — each law potentially applying to a parallel universe. This central idea will be the foundation of this book; while you need not understand it yet, hopefully you should have a vague inkling, a partial conception, of its meaning. Let these concepts stir in your head as we turn to investigate mathematics.

Imaginary Numbers

Most of us, even from our elementary school days, have pictured numbers as lying along a line—the so-called "number line." With zero at the center, negative numbers at the left, and positive numbers at the right, the "number line" offers a natural visual interpretation of arithmetic and algebra.

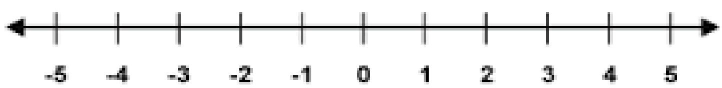

Fig. 1.: *The infinite number line*

Imaginary numbers are "quantities" which exist outside this line. They can be pictured floating "above" the number line in a two-dimensional plane. Imaginary numbers, and their cousins, complex numbers, can be used to solve any standard equation of elementary algebra.

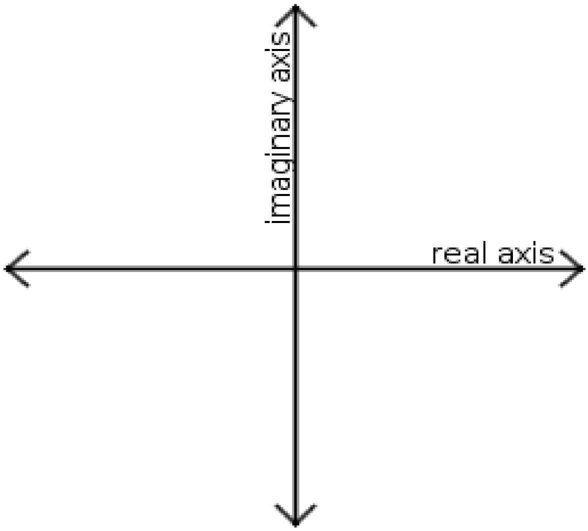

Fig. 2.: *The complex plane: Ordinary numbers on the horizontal line, imaginary numbers on the vertical line, and complex numbers in-between.*

Formally, as we shall see in Chapter 5, imaginary numbers can be defined as the square roots of negative numbers. Within the plane of imaginary numbers, arithmetical operations including addition, multiplication, and exponentiation become geometrical operations. For example, squaring a complex number involves simply squaring its distance from the origin, and doubling its angle with respect to the positive number line (see **Fig. 3**). This transformation of algebra into geometry is an intriguing quality of the "complex plane," where all the imaginary and complex numbers exist.

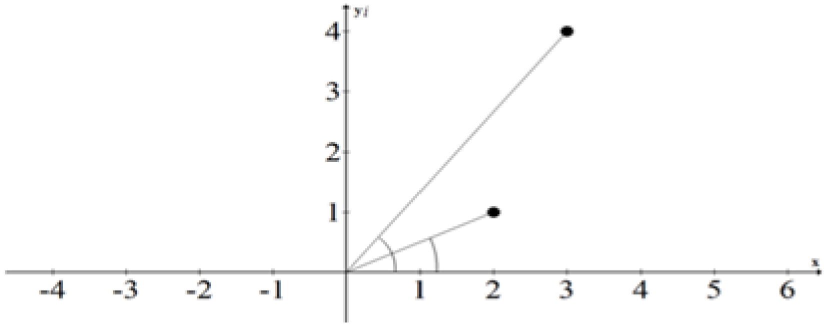

Fig. 3.: *To square a complex number: double the angle, and square the distance from the center of the plane*

Throughout history, the notion of “number” has been generalized and extended to broader realms. Although we first conceived of the natural numbers (1, 2, 3 . . .), the concept of fractions proved useful for agriculture, engineering, and finance. Soon, the irrational numbers (that cannot be represented as fractions), the concept of zero, and the notion of negative numbers all found practical use within society. The concept of imaginary numbers, existing outside the number line in a broader number plane, is a natural continuation of these developments. Ultimately, imaginary numbers have found great application in electrical engineering, and in simplifying problems of vector analysis.

QCI Theory infuses imaginary numbers into the laws of quantum physics, generalizing the Schrodinger equation to new realms. The complex plane offers new variety to the equations of quantum theory, a cornucopia of possibilities. The result of this generalization is a description of many different laws of physics, corresponding, perhaps, to an infinity of different universes.

While this idea is tentative, there is certainly a possibility that it might be confirmed by experiment. If true, QCI Theory would indicate that our cosmos is much larger than ever thought before.

Endless Alternate Realities

By infusing the complex plane, and the variety of the imaginary numbers, into the mathematical laws of quantum physics, QCI Theory predicts a diversity of universes far greater than ever imagined. By freeing physics from the restraint of the number line, and into the greater domain of the complex plane, the QCI hypothesis allows us to consider a smorgasbord of parallel realities, alternate worlds, and different laws of physics. In most of these realities, matter and energy decay into nothingness, and the nature of electromagnetism is entirely different. It seems that most universes would be barren voids, but in some parallel universes, alien forms of life might evolve.

In Chapter 7, we shall develop an "atlas" of parallel worlds, illustrating our location in the multiverse. In Chapter 8, we shall take a hypothetical tour of these alternate universes and planes of existence, describing how they might appear to a visitor. Feel free to skip to these chapters if these ideas pique your interest; however, to those readers wishing to discover the foundations of this theory, I recommend reading the book in order.

The Structure of This Book

Part II focuses on established mathematics and physics, explaining the background needed to understand QCI Theory. Part III introduces the theory, describing its mathematical foundations, and its implications for the structure of reality. At the conclusion of the book, two appendices offer the original physics paper from which this research is drawn upon, as well as an introduction to the relevant mathematics for the layperson.

In Chapter 2, the bizarre world of quantum mechanics is described, and the ideas of superposition, entanglement, and uncertainty are discussed. Chapter 3 continues this study of quantum theory, discussing the essential "path formulation" of particle physics, as well as the "many worlds" interpretation of quantum theory. In Chapter 4, we shall meet the mathematical foundations of quantum theory, the crux of the QCI hypothesis. Chapter 5 continues this mathematical investigation with an in-depth study of imaginary numbers.

Finally, in Chapter 6, QCI theory is introduced, drawing upon the background of previous chapters in describing the generalizations of quantum theory. In Chapter 7, an "atlas" of parallel universes is created, and in Chapter 8, this atlas is used to chart a hypothetical voyage to other worlds. Chapter 9 describes the "anthropic principle," and the conditions required for life to evolve in the multiverse. In Chapter 10, we investigate the possibility for experimental verification, and finally, in Chapter 11, the way forward for research is described.

At the conclusion of every Chapter is a list of “essential ideas” needed to understand succeeding Chapters. Furthermore, a glossary is provided to elucidate the meanings of physics terms. Sections labeled with an asterisk (*) may be skipped at the discretion of the reader, but offer a more complete and thorough discussion of the relevant topics.

This book is designed to be accessible for the average layperson. Only an elementary knowledge of high school science and basic algebra is required (mathematical concepts are reviewed in Appendix II). For professional physicists, the essential paper is attached in Appendix I. Although the ideas contained herein may, at times, be complex and intricate, I hope that this remarkable intellectual exploration of parallel universes may prove rewarding.

<u>Essential Ideas</u>

· *Multiple theories of physics suggest the existence of* ***parallel universes****, alternate realities governed by different laws of Nature*

· *The* ***Laws of Physics*** *are the fundamental principles describing the behavior of matter and energy*

· ***Quantum theory*** *describes the behavior of microscopic particles, which follow entirely different laws of physics than large objects*

· ***Imaginary numbers*** *appear outside the usual number line, instead existing within a two-dimensional plane*

· *By generalizing the equations of quantum theory with imaginary numbers,* ***QCI Theory*** *predicts the existence of a variety of parallel universes, governed by different laws of physics*