

# ENTANGLED REALITIES

THE CONFLICT AND COLLABORATION  
BETWEEN PHYSICS AND MATHEMATICS



$P = (E/c, p)$   
 $K = (\omega/c, k)$   
 $E$   
 $\omega = 2\pi f$   
 $\hbar = h/2\pi$   
 $c$

$$\Psi(x,t)\Psi(x,t)$$

$$p_x^2 + p_y^2 + p_z^2 + L_x^2 + L_y^2 + L_z^2 = E^2 - (mc)^2$$

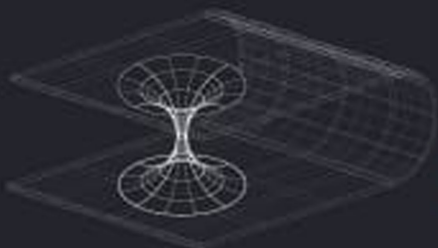


$$\frac{-\hbar^2}{2m} \frac{\partial^2 \Psi(x,t)}{\partial x^2} + U(x) \Psi(x,t) = i\hbar \frac{\partial \Psi(x,t)}{\partial t}$$

$$\hat{H} = \sum_{n=1}^N \frac{\hat{P}_n^2}{2m_n} + V(x_1, x_2, \dots, x_N)$$

$$H(t) |\Psi(t)\rangle = i\hbar \frac{d}{dt} |\Psi(t)\rangle$$

$$(E - q\phi)^2 - (pc - qA)^2 = (mc^2)^2$$



GOVIND PATHAK



# ENTANGLED REALITIES

## The conflict and Collaboration between Physics and Mathematics

**Edition II**

**Author**

Govind Pathak



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# Prologue

In the beginning, there was wonder.

Before mathematics had its symbols and before physics had its laws, humanity looked up at the stars and asked the oldest questions: What is this universe? Why does it behave the way it does? What governs the rising sun, the falling apple, or the arc of a thrown spear?

Out of this awe, two great languages of understanding were born. One used precision and abstraction. The other used observation and experimentation. Mathematics and physics siblings in the search for truth grew side by side, sometimes in harmony, sometimes in tension.

Mathematics dared to imagine perfect worlds of numbers, infinite dimensions, and unprovable truths. Physics remained grounded in what could be tested, measured, and observed. Yet time and again, they found themselves entangled. Newton's laws were written in the calculus he helped invent. Einstein bent space and time using geometry. Schrödinger's wavefunction danced to the rhythm of complex numbers.

But in the modern age, relationships have grown more complex. We now have physical theories that are too strange to be tested, and mathematical frameworks that seem to predict everything and nothing. Where once they walked hand in hand, physics and mathematics now sometimes peer at each other across a widening chasm.

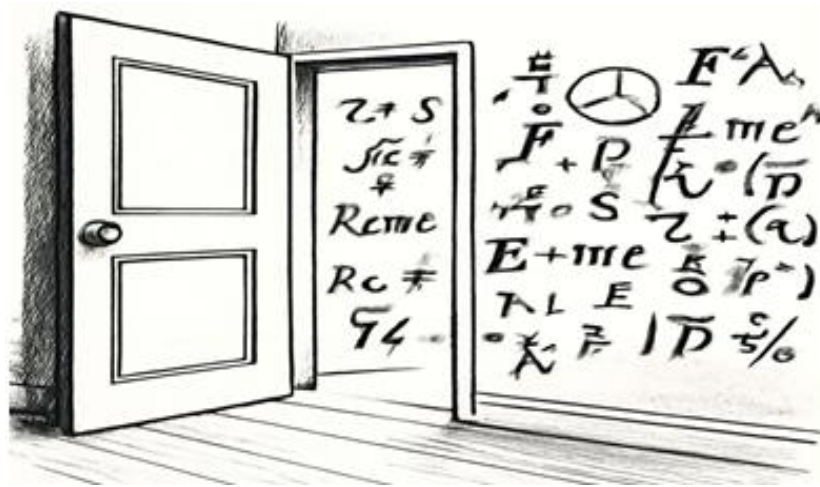
This book is about that chasm.

It is about the great collaboration that has shaped our world and the contradictions that now challenge its foundations. It is about ideas that dazzled and equations that defied. It is about the limits of human thought and the mysteries that lie beyond those limits.

Whether you are a physicist or a mathematician, a student or a seeker, a sceptic or a believer this journey invites you to step into the dance between the real and the rational. Between what we see, and what we can only describe.

Welcome to Entangled Realities.

# Preface: Entangled Realities



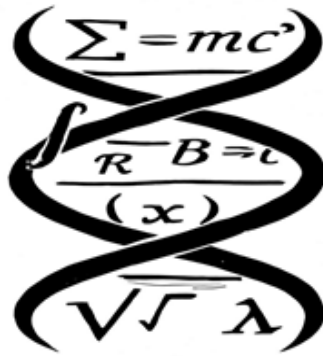
## 1. A Question Older Than Science

Before there were equations, there was wonder. Why do apples fall? Why do stars shine? Our ancestors sought answers in myth. But gradually, two languages emerged to explain the cosmos: **mathematics**, with its logic and precision; and **physics**, with its observations and experiments. This book begins with that ancient curiosity and asks: do these two languages describe the same reality, or are they speaking past one another?

## 2. The Dual Legacy



From Pythagoras to Einstein, the greatest breakthroughs in science often occur when math and physics align. Yet this relationship is not always smooth. There are moments of clarity when geometry bends spacetime. And there are moments of tension when elegant equations predict particles we never find. This legacy of **both harmony and conflict** shapes the narrative ahead.



### 3. Why This Book Now?

We live in an age of increasing abstraction. Quantum mechanics, string theory, and artificial intelligence all stretch the limits of both physical intuition and mathematical formalism. Meanwhile, philosophy, once the unifying voice, has been sidelined. This book returns to a central dialogue: **how do we know what we know?**

### 4. A Book of Thoughtful Contrasts

Each chapter of this book explores a facet of the relationship between physics and mathematics. At times, they act as **mirrors**. At other times, they are **mismatched gears**, slipping past one another. Rather than resolve the contradictions, we illuminate them offering the reader a deeper appreciation of both fields, and the spaces between them.

### 5. For Whom This Book Is Written

This is not a textbook. Nor is it a work of speculative fantasy. It is a philosophical and scientific **invitation**. If you are a physicist wondering if your models are too abstract, or a mathematician curious if your theorems map to reality, or simply a curious thinker drawn to big questions this book is for you.

### 6. Structure of the Journey

The chapters move from history to philosophy, from rigorous theories to unresolved questions. We explore:

- How physics gave birth to new math
- How math sometimes misleads physics
- What happens when both fail
- The rise of computation and AI as a third paradigm
- And the ethical, cognitive, and epistemic frontiers we must now face

## 7. A Personal Perspective

This book is also a personal journey. As a technologist and philosopher, I have spent decades working at the boundary of logic and experience. The questions that animate these pages are not abstract to me they are professional, intellectual, and deeply human.

## 8. What You Will Not Find Here

There are no equations to solve. No proofs to memorize. What you will find are **ideas** worth wrestling with, **questions** that linger, and **connections** you may not have seen before. You will find reflections from Einstein, Feynman, Gödel, and others not as idols, but as thinkers struggling with the same paradoxes.

## 9. The Hope of the Author

I hope this book deepens your curiosity. That it challenges and inspires you. That it arms you not just with knowledge, but with better **questions**. That it reminds you: the search for truth is not a solitary endeavour, but a collective voyage across disciplines, across centuries.

## 10. An Invitation

So welcome to the frontier. Welcome to the dance of logic and observation. Welcome to a space where certainty fades, and possibility expands. Welcome to the entangled realities of physics and mathematics.



# Book Summary: Entangled Realities

*Entangled Realities* is an intellectual expedition into the evolving relationship between physics and mathematics the two pillars of scientific thought. Blending historical insight, technical depth, and philosophical nuance, this book explores how these disciplines complement, contradict, and co-evolve.

Spanning from the abstract truths of mathematics to the empirical roots of physics, the book dissects foundational concepts, examines critical tensions, and poses urgent questions for the future of science in an age of AI and uncertainty.

With a narrative tailored for readers possessing a graduate-level understanding of science, it invites physicists, mathematicians, philosophers, and curious minds alike to reconsider the nature of truth, the boundaries of knowledge, and the destiny of scientific inquiry.

## Book Synopsis

**Title:** *Entangled Realities: The Conflict and Collaboration Between Physics and Mathematics*

**Genre:** Nonfiction, Philosophy of Science, Scientific Epistemology

**Audience:** Graduate students, researchers, academicians, and intellectually curious readers

### Part I – Foundations and Philosophy

- Lays the groundwork by defining what mathematics and physics fundamentally are.
- Explores their epistemologies, truth criteria, and philosophical underpinnings.
- Discusses formalism, realism, Platonism, instrumentalism, and the nature of mathematical and physical truth.

## **Part II – Harmony: Complementarity and Collaboration**

- Chronicles how mathematics has served as the language of physics across ages.
- Shows how physical discoveries have inspired entire branches of mathematics (e.g., calculus, Hilbert spaces).
- Presents examples of deep symbiosis: general relativity, Dirac’s equation, string theory.
- Explores mathematical elegance and beauty as heuristic guides in theory building.

## **Part III – Tension: Conflict, Crisis, and Limits**

- Investigates cases where mathematical formalisms mislead or outpace physical insight.
- Explores limits of measurement, idealizations, and non-empirical theories like string theory and multiverse cosmology.
- Critically evaluates the problems of falsifiability, undecidability, and the metaphysical status of physical laws.
- Highlights philosophical dilemmas around abstraction, interpretation, and meaning.

## **Part IV – The Future: Reconciliation or Divergence?**

- Explores how AI and empirical modelling challenge traditional roles of theory and mathematics.
- Considers information theory, category theory, and emergent behaviour as new unifying paradigms.
- Delves into Gödel’s incompleteness, epistemic ceilings, and the evolving boundary of knowability.
- The Silent Frontier: Where Physics and Mathematics Fall Silent
- Concludes with a vision for the co-evolution of physics and mathematics and the role of human intuition and imagination in pushing their boundaries.

## **Themes and Philosophical Questions**

- Is mathematics the ultimate reality or just a tool of description?
- Can there be physics without mathematics or mathematics without physical interpretation?
- What are the limits of formal knowledge, and where does intuition take over?

- Will future science be shaped more by logic, by data, or by machine intelligence?
- What is the role of beauty, mystery, and metaphor in the pursuit of truth?

*Entangled Realities: The Conflict and Collaboration Between Physics and Mathematics*

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# ABOUT THE AUTHOR



**Govind Pathak** is a lifelong learner, deep thinker, and bestselling author who believes that curiosity is the greatest human strength. With a career spanning global technology leadership and innovation, he has spent years exploring the hidden connections between science and human understanding. His bestselling book *Entangled Realities* transforms physics and mathematics into relatable, thought-provoking insights for everyone. Govind's mission is simple: to inspire people to ask better questions, think beyond boundaries, and rediscover the wonder in everyday life.



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