

A Fractal  
Epistemology for a  
Scientific Psychology



# A Fractal Epistemology for a Scientific Psychology:

*Bridging the Personal  
with the Transpersonal*

Edited by

Terry Marks-Tarlow, Yakov Shapiro,  
Kathe P. Wolf and Harris L. Friedman

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Bridging the Personal with the Transpersonal

Edited by Terry Marks-Tarlow, Yakov Shapiro, Katthe P. Wolf  
and Harris Friedman

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NO ONE WILL BE CONSIDERED SCIENTIFICALLY LITERATE  
TOMORROW WHO IS NOT FAMILIAR WITH FRACTALS.

—JOHN ARCHIBALD WHEELER, PHYSICIST



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## ADVANCE PRAISE FOR THE BOOK

“Fractals are the essence of being human, not just in the building of our lungs, our nerves and our bloodstreams, but in our individual and collective behaviors. This is the brave new world for fractal researchers. *A Fractal Epistemology for a Scientific Psychology* belongs firmly to this exciting world and its quest to bridge the personal with the transpersonal will broaden the scope of fractal thinking. In my discussions with Mandelbrot, he was delighted to see fractals venture from their mathematical shell and shake the world. He would have been delighted to read this book.”

—Richard Taylor, PhD, Professor of Physics, Psychology and Art, Head, Department of Physics, University of Oregon; author of 315 publications, including 12 in *Nature* and 4 in *Science*; 52 awards for research and teaching spanning the arts and sciences, including an InnoCentive Prize, Cottrell Scholarship, Pollock-Krasner Residency, Nobel Foundation Travel Award, and a British Royal Society Award.

“Intellectually engaging and provocative, *A Fractal Epistemology for a Scientific Psychology* provides the reader with exciting perspectives on the promise of fractal mathematics and geometry for illuminating mind, behavior, and consciousness. Its potential applications to transpersonal psychology are particularly noteworthy and are likely to serve as the basis for new avenues of research and theory development. This book will be a challenging but delightful read for scientists and erudite laypeople with an interest in fractals and consciousness.”

—Douglas A. MacDonald, PhD, Associate Professor of Psychology, University of Detroit Mercy; Associated Distinguished Professor, California Institute of Integral Studies; Associate Editor (Research) of *Journal of Transpersonal Psychology*; Senior Research Editor of *Journal of Humanistic Psychology*.

"Fractal Epistemology, as presented in this timely and inspiring collection, is a breath of fresh air in the closed room of traditional epistemology. This book offers a truly expansive freedom of thought that can liberate us from the imprisoning dominance of epistemologies of patriarchy. Understanding fractals can help us to develop an inclusive model of thought that is more reflective of feminine, and feminist perspectives. This important book is

vital to the expansion of our understanding of thought that sheds light on the hidden dynamics of all the forgotten and ragged edges of thinking and feeling that are neglected or misunderstood through more standard psychological models. *A Fractal Epistemology for a Scientific Psychology* is the first academic approach I have found to provide me with truly nuanced methods of understanding experiences of trance state awareness and insights. These essays help to explore with subtlety the experiences of insight in liminal and meditative practices like Yoga Nidra and allied states of being, such as dream, recollection, and intuitive knowing invoked through ritual trance induction in indigenous, earth wisdom practices of ceremony and story."

—Uma Dinsmore-Tuli PhD, Author of *Yoni Shakti: A Woman's Guide to Power and Freedom through Yoga* (2014) and *Nidra Shakti: A De-Colonizing Encyclopaedia of Yoga Nidra* (2020), co-founder of International Yoga Nidra Network.

"After more than a century of trying to explain "what is personality?" psychological theory and research brought us much closer to an understanding of a psychologically healthy human being that integrates emotion, experiences, cognition, behaviors, and traits into a more holistic view of the person. *A Fractal Epistemology for a Scientific Psychology* opens a new vista that deploys the mathematical properties of fractal geometry—non-integer dimensions, self-similarity, scalability, and self-organization—to the understanding of how minds move and change over time and co-evolve with a changing environment. The contributions to this volume use fractal geometry to identify qualitative patterns and explain how emergent dynamics lead to holistic phenomena. They also present some intriguing speculations as to how synchronicity, telepathy, psychokinesis, clairvoyance, and pre-cognition could be identified and understood if they were investigated from this new vantage point."

—Stephen Guastello, PhD, Editor-in-Chief of *Nonlinear Dynamics, Psychology, and Life Sciences*, Professor of Psychology, Marquette University.

"A rich, wide-ranging collection of creative chapters on the fundamental roles of fractal patterns in nature and the human experience, especially in transpersonal contexts, including psychotherapy. Destined to become a classic in the field."

—Allan N. Schore, PhD, Author of *The Science of the Art of Psychotherapy* and *Right Brain Psychotherapy*.

“*A Fractal Epistemology for a Scientific Psychology* is a prodigious and much-needed exploration into not just what are quite literally the building blocks of our world, but also into the underpinnings of our unique experiential worlds and interpersonal relationships. Marks-Tarlow and her combined authors, each from their own unique perspective, offer a strongly integrative tour de force into the realms of personal, transpersonal, and scientific phenomena while mounting a successful argument for the integration and synthesis of historically incommensurable schools of thought. Along with investigating vital, contemporary conceptualizations of our fractal world, *A Fractal Epistemology* persuasively and artfully reunifies the objective and the subjective, the scientific and the transpersonal, providing essential avenues for disparate disciplines to join hands in exploring how our world, including our emotional lives, actually lives and breathes.”

—William J. Coburn, PhD, PsyD, Founding Editor Emeritus of *Psychoanalysis, Self and Context* (formerly the *International Journal of Psychoanalytic Self Psychology*); author of *Psychoanalytic Complexity: Clinical Attitudes For Therapeutic Change* (2014, Routledge); Associate Editor of *Psychoanalytic Dialogues*; Faculty Member and Training and Supervising Analyst of Institute of Contemporary Psychoanalysis, Los Angeles.

“This is exactly the book I have been waiting for! It establishes transpersonal psychology as a full-fledged member of scientific psychology.”

—Stanley Krippner, PhD, Associated Distinguished Professor, California Institute of Integral Studies, Co-Editor of *Varieties of Anomalous Experience: Examining the Scientific Evidence*.

“In an era mesmerized by binary technology, where our society is in danger of losing its human sensitivities, the field of transpersonal psychology attempts to embrace all that is the mystery of individuality and relatedness. *A Fractal Epistemology for a Scientific Psychology* promises the reader a bridge back to our unique selves, while at the same time offering a visual path that returns us to the inseverable bond that ties us to each other and to our natural surroundings. This beautifully balanced compendium fills the reader with hope to return us to a humbling sense of that which may join us together, rather than what separates both hearts and minds. How extraordinary to fill pages with such a mix of both precision and poetry. If “big bang” theory doomed us to social fragmentation, the authors’ imagination about fractals may hold the promise of a psychology that

returns us to a harmony of human experience. Like modern day Kabbalists, the authors remind us of the economy of the universe of human experience.”

—Rabbi Peter M. Rosenzweig, PhD, Faculty, Division of Clinical Psychology, Northwestern University; Machon Shiluv Institute for Marital and Family Therapy, Jerusalem. Author of *Married & Alone: The Way Back; Introspection; Teshuva and Personality; What did the Prophets Say?* and numerous articles on the art and science of psychotherapy.

“Surprise! Our lives don’t manifest in straight lines or fixed dualities but in a dynamic matrix of intertwined possibilities and permeable boundaries, limned by the fractal, self-similar, “fingerprints of chaos,” across evolving infinities, present and potential. New understandings emerge for empathy, altruism, expanded self, exceptional experience, creativity, culture, and more. This book is a “must” as we enter a new era.”

—Ruth Richards, MD, PhD, author of *Everyday Creativity and the Healthy Mind: Dynamic New Paths for Self and Society* (a 2018 Silver Nautilus Award winner) and co-editor of the forthcoming book, *Nonlinear Psychology: Keys to Chaos and Creativity in Mind and Nature*.

“This remarkable, well edited collection provides a broad, thorough study of fractals with applications to psychology. Working to span subjective and objective aspects of reality, important bridges are built between personal and transpersonal. The archetypal nature of fractals shines forth throughout the text, granting greater access to a new scientific holism, offering much needed renewal for psychology at this time. The editors have provided a valuable gift to interested readers.”

—Joseph Cambray, PhD, President/CEO Pacifica Graduate Institute; Past President of International Association for Analytical Psychology; U.S. Editor of *Journal of Analytical Psychology*; Author of *Synchronicity: Nature and Psyche in an Interconnected Universe*.

“Transpersonal psychology is at a crossroads, at the centre of which is the meaning of a seemingly simple term, *naturalism*. One path holds that nonmaterial beings and transcendent experiences cannot be squeezed into the container of naturalism; the other expands the container, emphasizing the mysterious and multidimensional basis of our natural order. As this book so richly illustrates, *A Fractal Epistemology for a Scientific Psychology* has the potential to place a much-needed signpost at the crossroads. The authors collected in this ground-breaking volume demonstrate the ways in which transpersonal phenomena follow the logic of fractals and open an

epistemological approach that aligns transpersonal psychology with naturalistic science. Essential reading for a 21<sup>st</sup>-century transpersonal psychology!”

—Brian Les Lancaster, PhD, Professor Emeritus of Transpersonal Psychology, Liverpool John Moores University, UK; and Founding Director and Academic Dean of the Alef Trust.

“*A Fractal Epistemology for a Scientific Psychology* explores the role of fractals in illuminating the knowledge of our interconnectedness with all that is. As an indigenous Maya familiar with ancient sacred geometry such as the Mayan calendar, I found rich possibilities explaining a very complex subject in relationship with our psyche. I endorse the book as important contribution to this field.”

—Yoland Trevino, International Ambassador of the Maya Confederacy, Guatemala.

“Fractal thinking transfers perspective from one knowledge space to another, from one scale to an entirely other one—that’s the key to finding ways to understand people at the scale of new human interconnections. That’s the fascinating perspective that this book outlines for our futures of human change.”

—Franco Orsucci, MD, Professor, Niccolo Cusano University, London; Visiting Professor, University College, London; Founding Editor of *Chaos & Complexity Letters*; author of *Neuroscience in the Age of Complexity* and *Human Dynamics*.

“This book is a revolutionary and evolutionary landmark in publishing! Vast in its wide-ranging capacity to unify science and mathematics and the personal and transpersonal dimensions of psychology with a scientific rigor that has never been so clearly presented. The expansive and universalist perspective this book embodies fits perfectly into the ancient Taoist worldview and organic sensibility as well. The book is a joy to read. Using styles ranging from scientific to transcendent, the volume perfectly captures the voices of nearly 20 major theorists—scientists, neuroscientists, psychologists, psychiatrists, scholars, philosophers, and visionary thinkers—to express a common passion for never settling for reductionist arguments and always respecting the ways in which we, as part of the intricate web of nature, reflect and contribute to a wholistic vision that both includes yet transcends us all. Reading *A Fractal*

*Epistemology for a Scientific Psychology* is delving into a sumptuous feast for the mind and senses.”

—Carl Totton, PsyD, Director of Taoist Institute, Los Angeles, California; Host of regular podcast: *What’s this Tao All About?* Psychologist in private practice and consultant; Former Professor and Department Chair, School Psychology, Phillips Graduate Institute.

“This is a mind-expanding volume for those interested in understanding how complex psychological phenomena can be modeled by the rich and robust mathematics of fractals. As just one lucid example, the author contrasts the stepwise linear logic used by the conscious mind with the dreaming mind, illuminating its fractal nature that sees symmetrical equivalence of wholes with their parts.”

—Shan Guisinger, PhD, clinical psychologist and evolutionary biologist; co-editor of the forthcoming book, *Nonlinear Psychology: Keys to Chaos and Creativity in Mind and Life*.

“This is a *wonderful* book, with contributions from an all-star cast! Whatever you already know or don’t know about fractals, whatever your interests in the wonders and puzzles of human consciousness: This volume provides new entry points for grasping these instantly appreciated—as well as notoriously difficult—phenomena, and then offers path after fascinating path toward deeper knowledge.”

—David Schulberg, PhD, Professor of Psychology, University of Montana; Director of evaluation, National Native Children’s Trauma Center; co-editor of the forthcoming book, *Nonlinear Psychology: Keys to Chaos and Creativity in Mind and Life*.

## CONTRIBUTORS

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**Katthe P. Wolf, MA**, has returned to academia after a 30-year-hiatus spent building a successful non-profit career in family support, social justice, and child abuse prevention, currently serving as CEO of Be Strong Families. Wolf is currently a doctoral student in Integral and Transpersonal Psychology at the California Institute of Integral Studies with a research interests in fractals, fractal epistemology and the nature of self. She recently served as guest-editor on the special focus issue of the *International Journal of Transpersonal Studies* on the potential role of fractals for modeling transpersonal phenomena and synthesized the commentators' perspectives in her own: "The Nature of Nature is Fractal."

**Harris L. Friedman, PhD**, is retired Research Professor of Psychology at University of Florida, Distinguished Consulting Professor at the California Institute of Integral Studies and Visiting Scholar (2019-2020) at Harvard University. He also practices clinical and organizational psychology, and has written extensively on transpersonal psychology,



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**Katherine Peil Kauffman, MA**, is an affiliate of Northeastern University and the *Harvard Divinity School*. As Founding Director of non-profit EFS International, whose mission is to foster global emotional wisdom, she is especially interested in an evolutionary perspective on how the new biology of "emotion" can shed light on various mind-body conundrums.

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**Allan Combs, PhD**, is a transpersonal psychologist, consciousness researcher, neuropsychologist, systems theorist, and President of The Society for Consciousness Studies. He holds appointments at The California Institute of Integral Studies (CIIS), where he is Director of the Center for Consciousness Studies; the Saybrook Graduate School; and the Graduate Institute of Connecticut, where he is the Director of the MA program in Conscious Evolution. Professor Combs is author of over 200 articles, chapters, and books on consciousness and the brain, including, *Consciousness Explained Better: Towards an Integral Understanding of Multifaceted Nature of Consciousness*, and the award-winning, *Radiance of Being: Understanding the Grand Integral Vision*. Professor Combs is also co-founder of The Society for Chaos Theory in Psychology and the Life Sciences; Co-Editor of the *Journal of Conscious Evolution*, and Editor of *CONSCIOUSNESS: Ideas and Research for the 21st Century*.

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**Larry Vandervert, PhD**, is a retired college professor who has published and edited works in the neurosciences, creativity, innovation, child prodigy giftedness, and science in general. His major research interest is in how, through practice, and in collaboration with the cerebral cortex, the cognitive functions of the brain's cerebellum constantly optimize both mental and behavioral performance. In his publications he has applied the findings of recent brain-imaging studies of the cerebellum to creativity (2003, 2007, 2015), the evolution of language (2011), of culture (2016), of child prodigies (2016), of play (2017), and the cerebellum's prominent role in the rise of *Homo sapiens* (2018). The cerebellum's prominent role in creativity will appear in *Encyclopedia of Creativity* (3rd ed.). Dr. Vandervert is a Fellow of the American Psychological Association since 1992, and now writes under theegis of American Nonlinear Systems. He presently lives in Spokane, WA, USA.

**Anthony S. Wright, PhD**, completed his doctorate at California Institute of Integral Studies in San Francisco on "Principle and Pattern: Zhu Xi and Complexity Theory—Completing Wisdom through Fathoming Organic Pattern," which sought parallels in fractal organic patterns in Chinese philosophy and complexity science. Previously a Lecturer in the Philosophy Department at Sonoma State University in Rohnert Park, California, he is currently an Assistant Professor in the English Taught Program in International Business, in the College of Management at Shih Chien University in Taipei, Taiwan. His fields of interest continue to be parallels of Chinese Philosophy and natural organic patterns found in complexity science. He has been a piano technician since 1970 and presently lives in Taipei, Taiwan.

**William J. Jackson, PhD**, is a Professor Emeritus who taught courses in comparative religion and Asian traditions in the Department of Religious Studies at Indiana University-Purdue University at Indianapolis. He earned his doctorate in the Study of Comparative Religion at the Graduate School of Arts and Sciences, Harvard University. He is the author of books and articles about archetypes in the lives and works of South Indian singer-saints, and books such as *Heaven's Fractal Net: Retrieving Lost Visions in the Humanities* (Indiana University Press, 2004); *The Wisdom of Generosity* (Baylor University Press, 2008); and *American Tricksters: The Shadow Side of a Culture's Psyche* (Cascade Books, 2014). Jackson expands upon the relevance of fractal geometry to transpersonal psychology by illuminating spiritual archetypes, inspiring wonder and awe, as well as providing a visual

lexicon for paradoxical concepts, such as existence as multiple, yet “all one” simultaneously.

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## FOREWORD

# THE PROFOUND NATURE OF FRACTALS

RICHARD TAYLOR

What do we see in the wispy edges of clouds, in the intricate branches of trees, and in the jagged peaks of a snowy mountain range? For many years, it was assumed that these images were a haphazard mess devoid of any pattern. However, the past fifty years have seen a remarkable revolution in the way we study nature's scenery, which has brought scientific inquiry and artistic views of nature closer together. At the heart of this revolution lies the discovery of intricate patterns called fractals. Dramatically referred to by many as the fingerprint of life, fractals have been shown to be the basic building block of many of nature's patterns, ranging from clouds, trees, and mountains through to our brains, blood vessels, and lungs.

No one should be surprised that nature uses fractals so prevalently. The fractal geometry of nature is profound, both in the simplicity of its construction and in the favorable properties that emerge. Fractals repeat patterns at increasingly fine magnifications. Yet, with this simple act, they build a rich and intricate shape possessing a level of complexity that Euclidean shapes such as triangles, squares and circles cannot match.

Mathematicians have studied the exotic consequences of this complexity since the 1860s. However, a century passed before Benoit Mandelbrot realized that nature was using this same pattern repetition to build the world within and around us. Upon his discovery, he struggled to find an umbrella term to unite the earlier mathematical work with that of nature. Marveling at the jaggedness of fractal lightning, he focused on its fractured character and, on a whim, morphed the Latin translation *fractus* into the now familiar term fractal.

Armed with this quirky name, a new era of understanding nature was welcomed in. Many subsequent studies were fueled by bio-inspiration—the

principle of learning from nature's repetition and applying it to artificial systems. For example, we now have fractal storm barriers based on coastlines, fractal solar panels based on trees, even my own fractal electronics based on neurons. Clearly, the future shines brightly for scientific applications of this building block of nature.

Even more exciting, fractals have the potential to build bridges from the sciences to the arts. Surely, artists and scientists have a shared interest in understanding fractals? For me, the most staggering factor in the story of fractals is that artists have been creating fractal patterns in their artworks long before these recent scientific breakthroughs. Examples include Leonardo da Vinci's drawings of turbulent rivers, Jackson Pollock's epic organic paintings, and M.C. Escher's mind-bending prints.

Pollock's fractals have even been shown to reduce people's stress-levels, perhaps explaining that magic feeling of awe that many people experience when facing one of his creations (Taylor, 2006). This deep resonance between the observer and their fractal world is not a new discovery. Experiments from the 1980s show that hospital patients recover far more quickly from major surgery when given a room with a view overlooking nature (Ulrich, 1984).

This effect is called fractal fluency—our eyes have become fluent in the visual language of nature's fractals. In a sense, we are “hardwired” to appreciate fractals. One theory for fractal fluency pictures fractals as being embedded deep in our psyche, perhaps forming the basic structure of the Jungian collective unconscious. Another theory builds on the fact that our eyes trace out fractal motions when searching for visual information.

Similar to the eye hunting through images, many animals undergo fractal searches through their terrains when foraging for food. Ongoing research looks to see if people's daily journeys similarly follow fractal patterns. This prevalence of fractal searches triggers a flood of more profound questions related to our human behavior. In terms of creativity, perhaps our minds exploit fractal searches when exploring the landscapes of our imaginations? If so, perhaps our minds use fractals to drive many emotional, cognitive, and spiritual aspects of our lives?

Such human questions might surprise those who associate fractals with their mathematical origins. However, as Galileo is often quoted, “the book of nature is written in the language of mathematics.” In fact, a number of

defining studies on the road to Mandelbrot's discovery foreshadowed the potential of fractals for exploring questions of humanity. Mandelbrot's work evolved from Lewis Richardson's 1950s work attempting to develop models of why nations go to war. Even earlier, Ralph Elliott's research from the 1930s pictured the stock market as following fractal up and downs, a phenomenon latter proposed to indicate that society exhibits a collective fractal mood.

In the future, we might well conclude that fractals are the essence of being human, not just in the building of our lungs, our nerves and our bloodstreams, but in our individual and collective behaviors. This is the brave new world for fractal researchers. "A Fractal Epistemology for a Scientific Psychology" belongs firmly to this exciting world and its quest to bridge the personal with the transpersonal will broaden the scope of fractal thinking. In my discussions with Mandelbrot, he was delighted to see fractals venture from their mathematical shell and shake the world. He would have been delighted to read this book.

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INTRODUCTION

TOWARDS FRACTAL FOUNDATIONS  
FOR TRANSPERSONAL SCIENCE

TERRY MARKS-TARLOW  
HARRIS L. FRIEDMAN  
YAKOV SHAPIRO  
KATTHE P. WOLF

This volume represents an expansion of a special issue of the *International Journal of Transpersonal Studies* that proposed establishing a rigorous epistemological foundation for transpersonal science based on the applications of fractal geometry (Marks-Tarlow & Friedman, in-press). We want to extend a heartfelt thanks to the broad range of colleagues who felt inspired to participate in this project. That such an esteemed group of physicists, biologists, mathematicians, psychiatrists, psychoanalysts, religious scholars, and neuroscientists were moved enough to weigh in on the subject indicates the wide-ranging potential of applying fractal mathematics across the spectrum of physical and social sciences. Whether as physical objects, spatial or temporal patterns, or mathematical attractors underlying the processes of emergence and self-organization, fractal dynamics are ubiquitous in nature. Fractals' presence on all sizes and scales of spatial, temporal and psychological complexity is precisely what elevates its epistemological candidacy.

Traditionally, the subject of transpersonal psychology has been primarily confined to humanist and postmodern thinkers, who often dismiss mathematics and the hard sciences as crude reductionist tools that do not apply in the transpersonal domain. A similar attitude is evident among many psychoanalytic thinkers who eschew the recent developments in neuroscience and neural network dynamics in favor of subjective and intersubjective exploration. However, just as unconstrained reductionist attitudes have served to marginalize consciousness and transpersonal



studies, they can also impede psychological and social theorists. Whether one focuses on objective reality at the expense of subjective experience or privileges psychological reality at the expense of its physical foundations—both approaches ignore systemic connections at different levels of complexity, while perpetuating the reductionist paradigm. Fractal properties of self-similarity, scale invariance, and trans-dimensionality offer a unique potential to build a conceptual bridge between materialist and psychological perspectives, helping us to expand the reductionist paradigm towards a rigorously scientific systemic-holistic perspective that has the potential to re-unify brain/mind, objective/subjective, and personal/transpersonal domains (Shapiro & Scott, 2018).

In putting forth a fractal epistemology, we do not wish to make a “one size fits all” claim. We are not asserting that fractal geometry is the only branch of mathematics worthy of providing metaphors and models for transpersonal phenomena. Swiss psychiatrist Carl Jung came to view numbers as the basic quality of existence. In crafting an archetypal theory, his theory of number doubled over as a theory of mind. Jung (1955/1973) attributed to number the power to bring inherent order into the chaos of appearances, referring to material existence less as objectively unfolding and more as subjectively perceived by an observer. For Jung, numbers serve as the most fundamental foundation of perceived reality, the place where observers and observed merge at the level of symbol, synchronicity, and meaning. In building a bridge between mind and matter, Jung and his dedicated follower, Marie-Louise von Franz (von Franz & Verlag, 1986), were interested primarily in the concept of numbers as founts of inexhaustible metaphor for conscious experience. Whether in dream, mythology or art, the number one tends to symbolize undifferentiated unity; two signifies the first distinction or duality; three indicates dynamic change and movement away from the static opposition, while four suggests stable manifestation. Jung viewed number as the realm where mind and matter meet, sometimes referred to as the *psychoid* level of existence and at other times the *Unus Mundus*.

Similarly, Spencer-Brown (1969) referred to mathematics as the *cradle of creation*, both abstractly in the domain of mind and concretely in the domain of matter. Within this psychophysical cradle of creation, the realm of mathematical abstraction is said to be *discovered* in so far as it is rule-bound and capable of uncovering quantitative facts about the workings of the external world. At the same time, it is also *invented* as an abstraction, indicating something qualitative about the subjective realm of mind and meaning. A seminal paper by Robin Robertson (1989), Jungian psychologist

and mathematician, expanded the concept of number as an archetype of order and traces a history of the qualitative development of human consciousness based on the evolution of quantitative, mathematical discovery. Robertson traced four major stages of human collective awareness. The first stage began with counting numbers, where products of mind and products of matter are symbolically merged. The second stage involved the purely abstract discovery of zero, an absence that becomes a presence, allowing for the modern numbering system and negative numbers necessary for the debt/credit system of economic exchange. The third stage involved the discovery of infinity, which allowed for calculus through the discovery/invention of limits and enabled measurement of complex and moving objects that served as the foundation for the modern scientific/technological society. Robertson's fourth stage began with the recursive mathematics of Gödel, who proved that no system of logic can be simultaneously consistent and complete. Gödel's method models recursive loops of consciousness necessary for self-reflection, as well as the nascent study of self-awareness, which uses the mind recursively to study the mind.

To provide a geometrical illustration, consider the Möbius band (see Figure v-1), which is made by cutting out a long strip of paper, giving it a half twist and then taping or gluing the ends together. The result is the topological oddity of a 2-dimensional object that occupies 3-dimensional space with only one side and one edge. The Möbius band functions like an Uroboros, or snake eating its own tail, prototypical symbol of self-creation, based on the workings of recursive feedback loops, where each cycle ending becomes a new cycle beginning (Marks-Tarlow, 2008; Robertson & Combs, 2002).

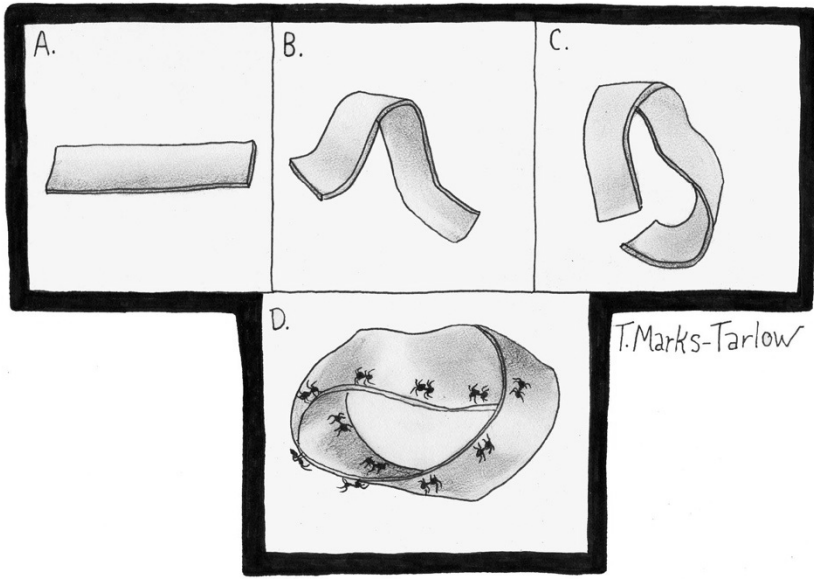


Figure v-1. Möbius Band. (From Marks-Tarlow, 2008)

A 3-dimensional equivalent is the Klein bottle (see Figure v-2), which starts with moving a Möbius band up one dimension by enclosing all the edges and stretching out its other aspects. What was the half twist at lower dimensions becomes a self-intersecting feature in higher dimensions. From our limited human perspective that is restricted to 3-dimensional space, the Klein bottle appears to contain both an inside and an outside. Yet, it is actually the 3-dimensional shadow of a 4-dimensional object, which, much like the psyche, has porous boundaries that interpenetrate its insides with its outsides.

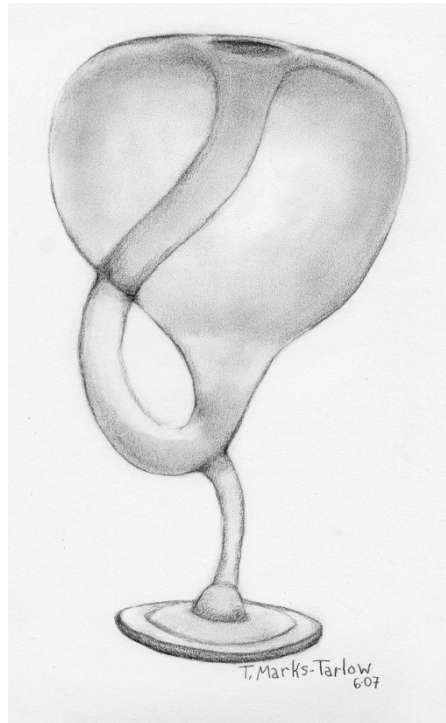


Figure v-2. Klein Bottle. (From Marks-Tarlow, 2008)

Both the Möbius band and the Klein bottle relate to fractals, in that they share the quality of being *interdimensional*. It is precisely this quality of *betweenness* that is so relevant to transpersonalists who love to explore interdimensional phenomena, such as mind travel through physical space or the mind's capacity to influence matter. The psychologist Steven Rosen (1994) has written a fascinating book, *Science, Paradox and the Moebius Principle: The Evolution of a "Transcultural" Approach to Wholeness*, which launches off these topological oddities to explore boundary crossings and paradoxes, such as "the two as one" within a philosophical position he dubs "nondualist dualism." Complementary positions are those of Roger Sperry's (1977) *monistic interactionism* and David Bohm's *active information* (1980/1997), which postulated a common informational substrate to all reality that differentiates into physical (brain) and mental (mind) domains in the ongoing fractal unfolding of evolutionary emergence.

The Möbius band and Klein bottle can be seen as precursors to fractal geometry. They are paradoxical, interdimensional objects with the concept of infinity implicitly tucked into their infinitely stretchable, topological spaces. By contrast, fractal geometry utilizes infinity more explicitly within the new concept of fractal dimensionality. The infinite stretch *between* ordinary dimensions is what renders fractal objects ideal for incorporation into religious architecture and art. To behold a progression of self-similar steeples as they unfold upwards from a Buddhist temple (see Figure v-3) is to get an embodied feel for fractals as grounded in the finite realm of matter, while stretching towards the infinite realm of spirit.



Figure v-3. Rajbana Vihara, Rangamati, Chittagong. (Public domain)

In a paper entitled, “Semiotic seams: Fractal dynamics of re-entry,” Marks-Tarlow (2004) extended Robertson’s history of human consciousness beyond the mathematics of Gödel, stating:

I argue for the importance of fractal dynamics to model entangled relations between observer and observed. To recognize the broad foundation of fractal geometry within infinite recursion on the imaginary plane can enhance our understanding of reality as finitely perceived in nature. Conversely, to comprehend how fractals manifest ubiquitously at the joints in nature, in turn, self-referentially expands our understanding of mind, especially the deep relativity that exists between observer and observed at all scales of

observation. I introduce self-similarity as a new symmetry in nature that represents the sign of identity. Explored semiotically, self-similarity can be seen as a distinction that leads to no distinction. I relate this paradoxical equivalence of change and no-change to the operation of cancellation within Spencer-Brown's arithmetic of first distinctions, as well as to Varela's reentry dynamics characteristic of autonomous systems. My thesis is that fractal separatrixes between inside/outside, self/other, subjective/objective levels, as well as conscious/ unconscious underpinnings of experience, represent an imaginary/real foundation for the entangled co-creation of world and psyche. (pp. 49-50)

The concept of infinity that bridges mind and matter also arises in the work of Ignacio Matte Blanco (1980), a Chilean psychiatrist and psychoanalyst. Matte Blanco developed a rule-based structure using the mathematics of infinite sets in order to make sense of a-logical aspects of primary process thought typical of the unconscious. According to Matte Blanco, the ordinary logic of the conscious mind conforms to additive, reductionist, asymmetrical properties of finite sets. For example, the conscious mind follows stepwise, Aristotelean, tautological, if/then logic: "If I do not do my laundry, *then* my clothes will not be clean." By contrast, the a-rational logic of the unconscious conforms to the symmetrical equivalence of wholes with their parts that is found within the mathematics of transfinite numbers, where for example, the set of infinite whole numbers is equivalent in size to any subsets, such as the set of all even numbers. Psychologically, Matte Blanco equated this property to children who generalize from parts to whole by calling all dogs "Fido," or adults who espouse racist ideology, equating each individual member of a group with properties attributed to the group as a whole.

In sum, we believe that the mathematics of fractals is rich and robust enough to model the *most complex* psychological phenomena, which corresponds to the Mandelbrot set as the most complicated mathematical object known to humankind (see Figure v-4). The chapters in this volume apply the unique properties of fractal mathematics within their respective fields.