World Business Academy

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ViewPoint
May 10, 2010

Cosmic Consciousness

Are We Truly Connected?
A Journey to Well-being, Happiness, and Success

By James A. Cusumano, Ph.D.

Editor's Note: As Deepak Chopra writes in the Forward to Jim's article, "In this remarkable article about the nature of true reality, Jim Cusumano explores the world of quantum physics and what it can teach us about consciousness and spirituality. Jim's explanation of the way theoretical physicists understand the nature of the reality-consciousness connection will open up a new world for many. He explains how scientists and the ancients have reached many of the same conclusions about the nature of the universe despite their different paths to truth and their different ways of knowing."

Jim has extensive experience as an entrepreneur, having founded several successful businesses, including Catalytica Pharmaceuticals, Inc., a billion-dollar public company. His career spans his five different professional lives—as a multi-million record sales recording artist; R&D Director for Exxon; CEO and founder of two public companies; founder, CEO, and Executive Producer for Chateau Wally films; and Chairman and owner of Chateau Mcely, an international award-winning luxury hotel and spa.

Jim is working on a new book, *My Little Book of Business—Tales of Purpose, Passion & Enterprise*, which he is excerpting in his new series in *Leaders Magazine* (formerly *Prague Leaders*). Jim can be reached at Jim@ChateauMcely.com.

About the Academy

The World Business Academy is a non-profit business think tank with the mission to inspire and help business to assume responsibility for the whole of planetary society. Since its founding in 1987, the Academy's work and extensive publications have addressed the challenge of innovative and values-driven leadership, renewable energy and climate change, development of the human potential at work, sustainable business strategies, and global reconstruction. In 2007, the Academy published *Freedom from Mid-East Oil*, by Jerry B. Brown, Ph.D., Rinaldo S. Brutoco, J.D., and James A. Cusumano, Ph.D.

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A Journey to Well-being, Happiness and Success

NASA, ESA, M. Livio and the Hubble 20th Anniversary Team (STScI)

By James A. Cususmano, Ph.D.

With excerpts from a lecture by Deepak Chopra, M.D.

Inspired by the *Wisdom of the Ages*

Contents

Forward by Deepak Chopra

A Personal Note

In this remarkable article about the nature of true reality, Jim Cusumano explores the world of quantum physics and what it can teach us about consciousness and spirituality. Jim's explanation of the way theoretical physicists understand the nature of the reality-consciousness connection will open up a new world for many. He explains how scientists and the ancients have reached many of the same conclusions about the nature of the universe despite their different paths to truth and their different ways of knowing.

I personally know Jim to be both an exceptionally successful businessman and a brilliant Ph.D. in physical chemistry. What started for him as a personal journey along his soul's path from his mind to his awareness has left us with a document that explains quantum thinking in simple terms, while revealing Jim's growing awareness of how to make sense of this multidimensional world we all inhabit.

I was pleased to learn that Jim was inspired to write this article after a Director of the World Business Academy gave him a CD of one of my talks. After listening to the CD, he researched existing knowledge about the quantum mechanics-consciousness-reality interface, went deep within himself to find its personal meaning for him, and finally, shared his insights with others.

What Jim has done is a model of how each of us can hear something and then take the extra effort to reflect deeply upon it in the expectation that when we really understand something of this nature, our lives expand as we embrace it within our field of consciousness. His essay is an example of how each of us can embrace the unknown and befriend it even as we surrender to it.

Jim's clear analysis and writing makes this incredibly rich material available to others. Perhaps, by his example, others will be inspired to expand their consciousness, and from that expanded place, embrace the profound yet simple unity of all things. In truth, we are all one.

Deepak Chopra, M.D.
Chopra Wellness Center
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Caveat Lector!

> ***"In the beginning there were only probabilities. The universe could only come into existence if someone observed it. It doesn't matter that the observer turned up several billion years later. The universe exists because we are aware of it."***
>
> *Lord Martin Rees, Astronomer Royal and President of the Royal Society*

It is considered anti-scientific and perhaps even blasphemous for someone technically trained to mix science with consciousness or spirituality. I therefore offer an upfront warning that despite my training in chemistry and physics, I am guilty as charged by those who read beyond this page and find themselves passionately disturbed by what at times may be a seamless blend of quantum mechanics and consciousness. However, you may wish to consider, as discussed in Part II of this essay, that our global physics community is slowly, albeit reluctantly, coming to terms with the fact that quantum mechanics and consciousness have been intimately intertwined essentially since the very beginning of time, *i.e.* since the Big Bang. In the past, with very few exceptions, physicists, who valued their reputation—and research funding—avoided even a hint of such "reprehensible behavior," that is unless they had already won a Nobel Prize and could care less about what others thought.

However, as we entered the 21st century, some physicists began to worry about the skeleton buried deep in their closet, *i.e.,* the implications of quantum mechanics[1] for what "true" reality is, versus what we perceive with our five senses. The outcome of this thinking has an interesting way of connecting with ideas that were conceived and practiced over millennia by those wise enough to intuit beyond what we perceive as natural physics. *The implications of what an increasing number of scientists have found at the interface of quantum mechanics and reality are not only profound, but more important, they are useful, practical, mindful, and have the power to bring you to a state of well-being, satisfaction and success that transcends normal expectations, and what might be considered conventional means to achieve the same goal.* In many ways quantum mechanics

[1] As used in this essay, the terms "quantum mechanics,' "quantum physics," "quantum theory" and "quantum science" are all synonymous.

rediscovered in the 1920s what Rumi, Jesus, Buddha and other wise spiritualists knew intimately and intuitively thousands of years ago.

> *"Where from do all these worlds come? They come from space. All beings arise from space, and into space they return: space is indeed their beginning, and space is their final end."*
> *The Upanishads, Hindu Scriptures*

In my opinion, and in that of an increasing number of concerned philosophers and scientists, the quantum mechanics-consciousness-reality interface provides the most effective insight into the only means to achieve wellbeing, happiness and success. But getting to that point under the influence of normal world views is challenging because we must overcome the taboo of mixing science and spirit, just as ancient alchemists—not the charlatans who called themselves alchemists—did before the advent of the scientific method. Indeed, the transition from alchemy to modern chemistry and physics led to a clean schism between science and philosophy. However, if you dig carefully, you will find a number of talented alchemists disregarded the division between these two disciplines. And why is this? Because the mission of the true alchemist was and still is[2] to improve upon Nature and the universe. Long before Charles Darwin, alchemists understood the essence of evolution, and they sought to actively participate in the process. They perceived the transition to the scientific method as a major setback in developing an effective means to deal with the critical issues of humanity.

Among many scientists of note, these concerned alchemists include Sir Isaac Newton, the father of classical physics, inventor of the reflector telescope, creator of the calculus, and father of numerous other discoveries which formed the basis of modern science and mathematics. Besides his obvious role in physics and mathematics, Newton was an ardent alchemist, and as clearly shown by a recent discovery of some of his lost writings, he spent more time researching that area than he did in the fundamental development of physics. He believed that the power of alchemy—an intimate combination of the sciences and consciousness—to be profound beyond most expectations and dangerous if not managed

[2] Alchemy is still practiced globally, albeit very quietly off the beaten path. Its practitioners are not unlike the secret societies such as the Rosicrucians and Masons.

properly. In a letter, written in 1676 to Robert Boyle, an alchemist and one of the founding fathers of modern chemistry, Newton begged Boyle not to disclose key alchemical secrets in his publications as they would be globally destructive if practiced without proper understanding. In his letter to Boyle he pleaded:

> Sir: I urge you to keep high silence in addressing these alchemical principles because the way by which the Mercurial Principle may be impregnated has been thought fit to be concealed by others who have known it, and therefore may possibly be an inlet to something more noble that is not to be communicated without immense damage to the world if there be any verity in the warnings of Hermetic writers. There are other things besides the transmutation of metals which none but they understand.[3]

The fact that Newton never published a single word on alchemy should not be taken as an indication of his failure at what the alchemists referred to as the "Great Work." Perhaps the incredible genius he demonstrated in his formulation of classical physics also penetrated his efforts in chemistry, but he felt his discoveries were better guarded in "high silence" for the benefit of humanity.

So, if you wish to take this precarious journey, then by all means, please read on. If not, I certainly understand, as some years ago, I probably would not have read beyond this page.[4]

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[3] In this passage, Newton is referring to the primary goal of the alchemist's research. It is called the "Great Work" and refers to the synthesis of the Philosopher's Stone, a minute amount of which is said to "catalyze" great wonders, *e.g.* the transmutation of base metals into noble metals *e.g.*, lead into gold, and the potential to heal any illness and impart an extended life span.

[4] For a well-written book that takes issue with much—but not all—of what is said in this essay, see *Quantum Gods—Creation, Chaos, and the Search for Cosmic Consciousness* by Victor J. Stenger (Prometheus Books, Amherst, N.Y., 2009). Dr. Stenger's position supports an atheistic view, and attempts to debunk Western and Eastern Theo-philosophies. His view is essentially at odds with the philosophers and scientists quoted throughout the present text.

Author's Note

> ***"And when you want something, the entire universe conspires in helping you to achieve it."***
> *Paulo Coelho, "The Alchemist"*

This essay came about because of a personal experience described in Part I. However, my experience would never have triggered writing it had I not received a CD from my good friend, Kathy Gardarian. Kathy and I are both friends of Deepak Chopra. I have lectured with Deepak, and have known him for several years, having met him through another dear friend, Rinaldo Brutoco, founder and president of the World Business Academy (www.WorldBusiness.Org), of which I am a member and served as its Vice Chairman for several years. Deepak is a long-time Fellow and supporter of the Academy.

Kathy sent me a CD of a lecture, entitled, "I Can Do It," given by Deepak in Las Vegas in May of 2007. She attended the lecture and knowing my interest in the subject—the nature of true reality—she kindly sent me a recording of the event. As usual, Deepak's presentation is impressive, to say the least. In Part I of this essay, ***The Case for Cosmic Consciousness***, I have used much of his lecture—often word for word—as it was impossible in my view to improve upon his perfection at many points in his presentation. In some places, I have omitted material for the sake of brevity, and in others, I have added my complementary thoughts. But in the end, the substance of Part I of this essay is Deepak's creation. I am merely the channel for his wisdom. Furthermore, any errors, technical or otherwise, are mine, and I take full responsibility for them.

Part I of this essay requires invoking a number of concepts from quantum mechanics. I have tried to incorporate them, without mathematics, within the text as needed. I have created Part II, ***A Primer on Conscious Quantum Mechanics*** for the reader who is interested in more detail concerning the evolution of quantum mechanics, the main players, and how they struggled with some of the profound implications of this subject as they apply to our discussion of reality in Part I. And in Part III, ***What Does This Mean For Your Reality?*** I have summarized my thoughts on the implications of Parts I and II. For the reader with no interest in the science and technology behind consciousness, it is possible to skip Part II,

without a loss of continuity, but at the expense of forgoing a deeper perspective as the basis of your true reality.

With considerable effort, the methods of quantum mechanics can be mastered and used in a practical manner. Developed nearly 100 years ago, quantum mechanics has been incredibly successful. It is arguably the only scientific theory ever developed for which not a single one of its predictions have ever been proven wrong. Today, it is responsible for products that make up more than 30% of our global GDP. Yet, as Niels Bohr, Nobel laureate and a founding father of quantum mechanics once insightfully noted, "Anyone not shocked by quantum mechanics has not understood it!"

In my view, it is even more profound that thousands of years ago, wise men such as Jesus, Rumi, and Buddha, perhaps by intuition, perhaps by spiritual connection, understood very clearly the intimate nexus between consciousness and "true" reality. However, it would take until the 20th century for physicists to "rediscover" this connection within the fundamentals of quantum mechanics. The unfortunate outcome is that modern intelligent people cannot readily access the true nature of this connection unless they are well-grounded in the higher mathematics of advanced calculus, differential equations, vector analysis, and linear algebra, as well as in the essence and fundamentals of modern physics. Yet, those theoretical physicists, who have this background and understand the nature of the reality-consciousness connection, have for decades shielded their understanding from extensive public disclosure. It has not been politically correct or professionally enabling to discuss, let alone to research this area.

However, over the last several years, some courageous physicists have come forward and are at least laying out the conclusions and implications of quantum mechanics for the reality-consciousness connection. Now it is possible to access a learned summary, although absent training in the relevant areas of physics and mathematics, you still must take much on faith. This, of course, makes it difficult for an interested non-physicist to distinguish between true physics, as best we understand the subject, and representations by misguided and/or misinformed writers, who perhaps mean well, but have an incorrect technical understanding of the subject. The non-technical reader must also deal with beguiling comments

from informed physicists who still prefer to skirt the issues and are negative about the reality-consciousness connection. So, dear Reader, unfortunately there is no easy answer, except—to be your own judge!

> *"It was not possible to formulate the laws of quantum mechanics in a fully consistent way without reference to consciousness."*
>
> *Eugene Wigner, Nobel laureate in physics*

My purpose in writing this essay was twofold. First and foremost, I found this an effective way to educate myself on a subject that is so important to me at this stage in my life. As good teachers often tell us, they learn more about a subject by teaching it than by straightforward study methods. That's the way writing works for me. For this reason, I did not concern myself about form, format and references, as I was not clear that this essay would ever see the light of publication. The second motivational force for writing this essay was to make it available informally to anyone who cares to read it, and convey to them what Deepak and the Wisdom of the Ages have to say on this subject, as well as my thoughts on how science and technology fit neatly together with the metaphysics and spirituality of consciousness.

> *"All such notions as causation, succession, atoms, and primary elements . . . are all figments of the imagination and manifestations of the mind."*
>
> *Buddha*

I sense throughout the world an increasing interest in, if not a movement towards, spirit and consciousness. That's good, as it's the only way we will ultimately "make it." My hope is that a meaningful slice of two key constituencies—corporate executives and political leaders—catch the fire. This is absolutely necessary to accomplish the daunting global challenges ahead of us over the next few decades. The corporate and political arenas spend large sums of time and money in teaching their employees, leadership, teamwork, and communication skills via conventional methods. Yet, the most fundamental long-term change in an individual to truly be able to address these areas starts within their "core," *i.e.*,

by learning to connect and communicate with their spirit and with the spirit of others. I do, however, recognize that not only scientists, but corporate executives and politicians as well, do not like to use the word "spirit," so perhaps we need to find an effective synonym, such as "consciousness" or "wisdom."

As someone trained in chemistry and physics, yet with a spiritual bent, I feel increasingly drawn to understand consciousness and its scientific basis, as I believe this can have such a positive impact in our increasingly troubled world.

James A. Cusumano
Chateau Mcely
Prague, Czech Republic
May 10, 2010

Part I
The Case For Cosmic Consciousness

"Everything we call real is made of things that cannot be regarded as real."

Niels Bohr, Nobel Laureate in Physics and One of the Founding "Fathers" of Quantum Theory

How It All Started

"There is no such thing as coincidence."
Paulo Coelho, "The Alchemist"

I awoke with a start at 6:00 a.m., with only one thought. "Did Obama win the election?" Living in Prague, nine time zones from the western U.S.—12 if you include Hawaii—means that we don't get the full scoop until the wee hours of the morning.

I slipped quietly out of bed, not to awaken Inez or little Julia, and made my way to the TV in the living room. A quick push of two buttons and there on CNN it was clear in a millisecond—Barack Obama had won by a landslide and would become the 44th President of the United States of America. Thank God! Like many Americans—but clearly not all—I was elated.

I waited patiently to hear his acceptance speech. As he delivered one incredible message after another, and with no apparent script, it was abundantly clear that this young man had come very far since his now famous presentation at the Democratic presidential convention on July 27, 2004. Many thought then, "This man will really fly; why, someday he could even be president!"

As I listened to Mr. Obama, the camera intermittently scanned the thousands of people in the audience. There were a few things that struck me. The demographics were clearly broad—people of all colors, well-dressed people, modestly-dressed people, rich, poor, children, men, women. Nearly every one of them was overwhelmed with tears of joy and relief streaming down their faces. It had been a long, difficult and contentious race. As I stared in amazement through my own welled-up eyes, I could not help but think, "All of these people look so connected, so much like one." In fact, as Barack Obama continued, in my solitude on that dark November morning, I felt deeply a part of them, as well. It was a most amazing and exhilarating experience.

This started me thinking about the reading I had done over the years by ancient wise men such as Rumi, Buddha, Jesus, Plato, Aristotle, Thomas Aquinas and many more. Before the Great Renaissance and the "Age of Wisdom," there was

no such thing as the Scientific Method. Philosophy, spirituality and science were tightly interconnected as is so evident in readings from the ancient alchemical texts. Those teachings maintain that every person has a spirit—a soul, if you like—and there is both an individual spirit and a collective or universal spirit, *i.e.,* all people are connected in some way not entirely understood. One of the greatest alchemists of all times and the father of modern physics, Sir Isaac Newton, professed this doctrine. However, this is rarely cited in modern texts, as it might discredit the marvelous scientific foundation he built for present day classical physics.

But the Inquisition and the works of Galileo, Kepler, Copernicus, and other great men of science changed all of that with the birth of the Scientific Method. They maintained that you must first postulate a theory; experiments are then designed to prove or disprove the theory; if proved, the theory is used to predict further outcomes; if these outcomes are observed as predicted, the theory is accepted as valid until an experimental result is observed that is not explained by the theory. Such is the foundation of all modern science—chemistry, physics, biology, etc. The scientific method would not work for experiments involving spirit and consciousness—at least not at our current level of understanding of the sciences and consciousness.

As I studied Mr. Obama and the crowd before him, I began to wonder about the implications of these ancient writings from the Wisdom of the Ages. Were the people in Obama's audience connected somehow at a deeper level, and if so was there a scientific basis for this? Was there some kind of energy field permeating their collective space? Why did I feel so intimately in touch with them? If there was some kind of field, did it "reach out" to me in some way? Are we all truly connected somehow; and what about other living things—plants, animals, and fish in the sea? What about "inanimate" objects such as mountains, the sea, the sky, the stars and planets, the universe itself? All of this came to me in a flash of meditation just after Obama's acceptance speech.

And then I recalled listening to Deepak Chopra's Las Vegas lecture. In this particular presentation, Deepak dealt with the connectivity issues that perplexed me

on that early November morning in Prague, as I listened to Obama's acceptance speech. I decided that evening to listen to Deepak's lecture again. It was truly an enlightening experience. I felt as though it touched every cell in my body.

In the following essay my intent has been to expand on Deepak's thoughts, and to provide perhaps just a slight, yet complementary shift to his presentation. I think his message is particularly prescient at this time as we struggle with the global crises of energy security, climate change, financial meltdown, poverty, and disillusionment.

Your Probability of Being

> ***"We don't exist unless we are deeply and sensually in touch with that which can be touched but not known."***
> *D. H. Lawrence, British novelist (1885-1930)*

"Why am I here? Where did I come from? Do I have a spirit or a soul? And if so, where will it go when I die? What's the probability of me being here in this universe, at this given moment in time? Is my very existence just a remote probability or an accident?" These are questions that most of us ask, sooner or later. The quantum-mechanics-consciousness connection points us in a direction that provides answers to these and related challenging questions.

If I think back only to my immediate grandparents, I am immensely impressed by the probability of my very existence. At the turn of the 20th century, my maternal grandparents, Giovanni Franciamore and Salvatore Catalano immigrated to Elizabeth, New Jersey from Cammarata, a small village in Sicily. My fraternal grandparents, Maria Federico and Vincenzo Cusumano immigrated at about the same time, also to Elizabeth and also from Cammarata, but surprisingly they did not know my maternal grandparents, while living in the same village. Cammarata is modest in size and not nearly as well-known as its infamous neighbor, Coreleone. What were the chances that all four of my grandparents would migrate some 5,000 miles away to the same place, not even knowing each other in their small village of origin, and that both families would each have a child, and that these two children would somehow find each other, fall in love, marry and give birth to me—James Anthony Cusumano?

Allow me to really make my point by going back just a bit further in time. I had 2 parents, 4 grandparents, 8 great-grandparents, etc. If I go back just 30 generations, the number of people directly responsible for my presence on this planet can be calculated from the following formula:

$$N = \sum_{m=1}^{m=30} 2^m$$

Please don't fret about the math; the interpretation of this equation is quite simple. N is the total number of people for all 30 generations, and m is the specific generation, 1st, 2nd, 3rd, etc. This simply means that we must sum $2^1 + 2^2 + 2^3 + 2^4 + \ldots$, which gives $2 + 4 + 8 + 16 + \ldots$, etc. all the way up to 2^{30}. The final number of people is precisely 2,147,482,646 or about 2.2 billion people; not millions or hundreds of millions, but billions of people. And if one of them had been missing, died prematurely, or had not been in the right mood, I would not be here! And that's true for you and for everyone on this planet. All you have to do is to go back just 30 generations, which to most people's surprise, is more than 2 billion people! So is your life and presence here on planet earth at this point in time just an accident or a coincidence? Is it a total statistical improbability? Well if it is, that's amazing! And if it's not, then that's amazing! It's amazing either way! Your very existence should throw you into a state of sheer ecstasy.

> *"If you're not perpetually surprised by the fact of your existence, then you don't deserve to exist."*
> *Rabindranath Tagore, Poet & Nobel laureate (1861-1941)*

If we consider modern cosmology, evolution theory, geological records and molecular genetics, there are two broad schools of thought on the nature of true reality. The first, ***Physical Cosmology***, maintains that everything that has happened since the beginning of time, *i.e.,* since the Big Bang, is a series of accidents. This includes your very existence and the existence of our planet, which after all is but one speck of dust in an infinite void, somewhere in the junkyard of infinity.

The second school of thought, ***Conscious Cosmology***, maintains that with bits and pieces of our everyday sensory experience, we cannot see the whole true picture. *What the first school of thought calls an accident is in this alternate way of thinking, part of a universe where everything is synchronized, everything is coinciding with, and everything is correlated with everything else in the universe. And in fact, there is no such thing as an accident.* This latter school of thought, ***Conscious Cosmology***, is the subject of this essay.

Conscious Cosmology *maintains that consciousness is the true ground of being. The consciousness that gives rise to your thoughts is also the consciousness behind all of the intelligent activity of the universe. This leads to the conclusion that there is no such thing as an accident. Each of us is part of the creative process of the ground of being and part of what we call infinite consciousness, which has no beginning or ending in time.*

Furthermore, this way of thinking maintains that there is a personal and a universal collective consciousness, and they are both tightly connected. *Personal consciousness or spirit or soul—whatever you choose to call it—is infinite and cannot be contained in the geometric confines of a human body or a lifetime.* It is, as we will see when we discuss the implications of quantum theory for reality, "non-local." *This means that your spirit or soul is not present in just one place in time or space, i.e., in space-time. It is present everywhere, and at all points in space-time. It always was, and it always will be.* Of course, this is not so for your body. As Buddha noted more than 2,500 years ago, "Life is like a bolt of lightning in the sky. It comes and then it goes." This premise is part of the basis for the Buddhists' belief in reincarnation. To get to this point, we must answer the question, "What is reality?"

What's Really Real?

> ***"Reality is merely an illusion, albeit a very persistent one."***
> *Albert Einstein*

There are three ways in which we seek to understand so-called reality. The first is through the eyes of the senses, *i.e.,* through the eyes of the flesh. If you want to know if there are craters on the moon, you extend the range of your visual sense of experience with a telescope to make this determination. If you want to know the shape and structure of a certain microbe, you explore its characteristics by amplifying your visual sense with a high-powered microscope.

The second way in which we seek to understand reality is through the eyes of the mind. If you want to understand the Theorem of Pythagoras, then you must know something about the principles of Euclidian geometry that exist in the mind. If you want to understand the theory of relativity, then you must understand something about the thought experiments that occurred in the minds of great scientists such as Einstein and others. If you want to understand quantum theory you must understand the mathematics and physical principles that occurred in the minds of great scientists such as Schrödinger, Heisenberg, Planck, Bohr, Dirac, Born, de Broglie and others. As demonstrated in Part II of this essay, and as all good quantum physicists know, but most prefer not to discuss, quantum mechanics is—without question—directly linked to consciousness.

Interestingly, quantum mechanics is responsible for more than 30% of the world's gross domestic product, whether we use e-mail, speak on a cell phone, surf the internet, or have laser eye surgery; *these technologies are all based on a fundamental premise of quantum science. That fundamental premise states that the material world is actually not material, that is to say, the physical world, as we perceive it with our five senses, is in reality, non-physical. It concludes in more general terms that all of the "stuff" of the universe is truly "non-stuff."* This follows from the fact that an atom, which is the basic unit of what we call physical matter, is not material. We like to think of an atom as Isaac Newton did, a solid ball, but in fact it is not a solid entity. Quantum mechanics tells us that the atom is a hierarchy of states of information and energy in a huge emptiness. All of these conclusions come from looking at the universe by going inside the mind.

This is the second way of trying to understand what we call reality. But there is a third way.

The third way of trying to understand reality is to look at the world and the universe through the eyes of your consciousness, *i.e.,* through your spirit or what some would call your soul. The motivation for this third approach to reality is summarized so well in a poem by William Blake.

"We are led to believe a lie
When we see with and
Not through the eye
That was born in a night
To perish in a night
While the soul slept
In beams of light."
William Blake

What Blake is saying in this poem, and what scientists who study perception confirm, is that our five senses deceive us. We can never know the true picture of reality by trusting our senses. Buddha made this point some 2,500 years ago.

"If you can see it, if you can touch it, if you can taste it, if you can smell it, if it is solid, if you can think about it, if you can conceptualize it, if you can visualize it, then—it is not real."
Buddha, ~2500 years ago

The reason for this is that as discussed in detail in Part II, reality through the eyes of the five senses is actually a projection of something that we cannot see, something that is invisible, something that we cannot imagine, something that cannot be conceptualized. *And yet, it is something without which we would not be able to imagine, something without which we would not be able to think, something without which we would not be able to perceive—and that something is consciousness.* This comes directly from quantum physics, not from metaphysics.

> *"What we perceive through the senses as empty space . . . is the ground for the existence of everything, including ourselves. The things that appear to our senses are derivative forms and their true meaning can be seen only when we consider the plenum, in which they are generated and sustained, and into which they must ultimately vanish."*
>
> *David Bohm, Quantum Physicist and Developer of Modern Quantum Mechanics*

We cannot trust our senses. After all, our senses tell us that the world is flat, but no one believes that any more. Our senses tell us that the ground we walk on is stationary, yet we know the earth is spinning on its axis at 1000 mph and hurling through space around the sun at 67,000 mph. Our senses tell us that our bodies are three-dimensional anatomical structures and that we are separated by distance in space and sometimes in time, as you are there reading this paragraph, and I am here writing it. Well, I promise you, all of that is a grand illusion! None of it is true.

*According to **Conscious Cosmology**, which follows directly from quantum mechanics, the universe is an interdependently co-arising confluence of space-time events (i.e., present as objects in time—past, present & future) in a field of consciousness that is beyond space-time (i.e., no beginning and no end).* Our senses are very deceptive. When we look at each other we see a three-dimensional anatomical structure that seems fixed in space and time. However, because the basic entity of construction of all so-called physical objects is the atom, which itself is not a physical object, our bodies are actually dynamic rivers of energy and information, constantly in exchange with all of the elements and forces of the universe.

Your Physical Body

> ***"The human body is a machine which winds its own springs."***
> *Julien Offroy de la Mettrie, Author, "L'Homme Machine"*

The physical body with which you began to read this essay is not the same physical body with which you are now reading this sentence. Because with each breath, you breathe in about $1x10^{22}$ atoms from the physical universe, *i.e.*, 1 followed by 22 zeros. With every breath that you exhale, you also breathe out $1x10^{22}$ atoms. And the majority of these atoms originated in every cell of your body. So, at the atomic level, you are literally breathing out bits and pieces of your liver, heart and brain tissue, and technically speaking we are intimately sharing our organs with each other all of the time! As the great American poet, Walt Whitman noted many years ago:

> *"Every atom that belongs to you, as well belongs to me."*
> *Walt Whitman*

This is no longer a metaphor of poetry; it's a scientific fact of biology. If we draw an imaginary spherical container around the earth, and recognize the dynamic equilibrium and exchange of atoms and molecules within the atmosphere with all living matter on the planet, we can do a calculation that demonstrates beyond a shadow of doubt that right at this moment, as you read this page, you have in your body at least 1 million atoms that were once in the body of Jesus Christ, or Buddha, or Genghis Kahn, or Saddam Hussein, or anyone else you might care to imagine. Because of this constant equilibrium exchange of atoms and molecules around the globe, in just the last 3 weeks, a quadrillion atoms, *i.e.*, $1x10^{15}$ atoms, 1 followed by 15 zeros, have gone through your body and have also gone through every other living species on this planet. So, envision a camel in Saudi Arabia, a taxi driver in Calcutta, a pigeon in China—you have atoms in your body right at this very moment that were circulating through these bodies, only 3 weeks ago.

In less than one year, you replace more than 98% of all of the atoms in your body by exchanging them for atoms from the global environment. At the atomic level, you recycle your liver every 6 weeks, your skin once a month, your stomach

lining every 5 days, your skeleton every 3 months, and even your DNA, which holds the memories of millions of years of evolutionary time, *i.e.,* the actual raw material, the carbon, the oxygen, the hydrogen, comes and goes every 6 weeks like migratory birds. So, if you think you are your physical body, you have a bit of a dilemma. Which one are you talking about?

I started typing the notes for this essay last year in 2009. The computer I am using at this very moment is the same one I used last year, but my body is a 2010 model, and my 2009 model is dead and gone. It came from the dust; it circulated around in what I call "myself"; it's now circulating in other life forms on the planet and in part is also back in the dust as well. So the actual physical body with which I started this writing project is dead; it's gone.

But as consciousness—and by consciousness I mean memories, dreams, imagination, inspiration, intuition, insight, creativity, and choice making—we are constantly outliving the "death" of the atoms and molecules of our so-called physical body through which we express ourselves while we are alive. So, in fact, in "reality," we must not be our bodies!

"We are such stuff that dreams are made of."
William Shakespeare

"Our bodies are just the place that our memories and dreams call home for the time being."
Vedanta and Buddhist saying

So if you could see the physical world as it truly is—not through the artifact of sensory experience, since your senses lie to you, you would see a radically different universe.

Sensory Lies

> ***"Common Sense is that which judges the things given to it by other senses."***
> *Leonardo da Vinci*

Our senses deceive us in a bizarre manner. Your brain which is responsible for your perception of the world has never had any direct experience of the world. How could it? Since birth, it's been locked up inside your skull. Your brain cells only respond to internal biological signals, such as changes in pH, electrolyte concentration, the presence of hormones, and body temperature. All of this biological activity ultimately turns into a binary code of plus and minus electrical charges across a cell membrane in a neuron. This binary code of charges within a cerebral neuron or brain cell gives rise to your perception and experience of the external world. How does it do this? It is very mysterious and it confounds the most brilliant scientists of our times. Indeed, we do not have a cogent explanation as to how we hear, see, feel, taste and smell.

> ***"The best explanation we have is that something unknown is doing we don't know what!"***
> *Sir Arthur Eddington, British Cosmologist (1882-1944)*

If you ask world-recognized scientists, who work at the forefront of our perception of reality, "What does the real world look like?" you will get a picture such as that provided by Sir John Carew Eccles, Nobel laureate for the discovery of synaptic neuron firings. In a seminal comment, he concluded, "I want you to know that there are no colors in the real world; there are no textures in the real world; there are no fragrances in the real world; what actually exists out there is some radically ambiguous and ceaselessly flowing quantum soup." The magic is in our consciousness, because out of that soup of energy, we conjure up in our consciousness a physical world, a universe. For example, take just a moment and think of a beautiful sunset on the ocean; can you see that picture in your brain? Of course, you can. Where is that picture? If I opened your skull and went inside your brain, I would not see a sunset, but just a binary code of plus and minus electrical charges going on and off. How does this electrochemical phenomenon create such a vivid picture in your brain? How does this kind of activity create

a sound, a taste, a smell? How does a series of plus-minus charges within your brain create the entire universe within your consciousness?

If you talk with fundamental scientists today, they will tell you that even though the world appears as pictures, sounds, tastes, fragrances, and textures, in reality it's not like that. So you might ask, "Then what's it like?" *The best answer that scientists can provide today is that it is a "**discontinuity**."* There are many kinds of discontinuities in mathematics, but for our purpose, we can consider the following definition. A discontinuity is a point at which a signal abruptly and instantly undergoes change, such as when a signal continuously goes on and off. Consider the graph in **Figure 1**. It is a plot of a mathematical function known as a square wave in two dimensions on an X-Y plane or graph. In our case, it can represent the on-off sequence of a light bulb. For values of X of 0, -π, and +π, the bulb goes from "off" to "on" or vice versa, depending on which direction we are moving on the X-axis. When the light is on, the value of its intensity is exactly equal to "a." We say that there are discontinuities at 0, $-\pi$, and +π because the bulb goes instantly from "off" to "on" or vice versa, and the value of Y at these points is "a" or "0," but nothing in between, hence the mathematical function representing this process is said to be discontinuous at these points. The signal is *vibrating* on and off.

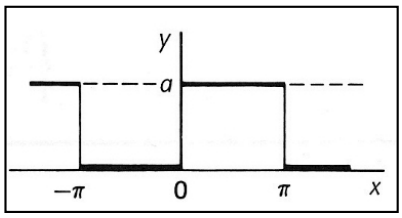


Figure 1. A Discontinuous Event

At the most fundamental level, what we call solid matter is made up of molecules, which are made up of atoms. Atoms are made up of subatomic particles such as protons, electrons and neutrons, and these subatomic particles are further made up of various forms of subatomic quarks, all vibrating in and out of an infinite void. And in fact, if you could see the world as it really is, you would see that you and I, and the chair you are sitting on, are as proportionately void as intergalactic space. And everything that you observe with your five senses is vibrating on and off at the speed of light, *i.e.,* 186,000 miles per second.

Your whole body, which you currently occupy as you read this paragraph and which appears solid to you, is actually trillions of vibrations that are going on and off. It is mostly empty space, 99.99%, and the 0.01% that appears to be material is also mostly empty space. You, me, and other material objects are made out of nothing. This is what Buddha called "Shunyata," the "great emptiness." The mystery is what is this "nothingness" from where we all come? Is it just a void, or could it be the womb of creation? Is it possible that Nature goes to exactly the same place to create a galaxy of stars, a cluster of nebulae, a rainforest, a human body, or a thought? What's a thought? Where does it come from? And after we have had a thought where does it disappear to? These are questions that some people have asked forever. Some sages, geniuses and psychotics have figured it out. There is a fine line between sages, geniuses and psychotics!

> *"We come spinning out of nothingness, scattering stars like dust. Look at these words, 'spinning out of nothingness.' This is within your power."*
> *Rumi, 13th century poet*

What we call the picture of the world is not the look of it; it's not what we perceive with our five senses. It is an on-off signal that has been going on and off for all eternity. It is this on-off signal that gives us the experience of the world. We need the on-off signal to have the experience of the world and the universe. Without the off there is no on. Without the on there is no off. That's what a discontinuity is—something that is vibrating on and off. When you see a light moving around a Christmas tree, there is no light actually traveling around the tree. The effect is created by light bulbs going on and off in a certain sequence, in which we cannot see the off, but only see the on, so our senses perceive and transmit the picture of a moving light within our consciousness. The same effect occurs in the sensory transmission of neon signs. Lights are not moving; bulbs are just going on and off in a prescribed sequence. This again is a discontinuity—a signal vibrating on and off. Another example is a movie film, where you see continuity on the screen, but the movie is actually a series of still frames that are going on and off. If the film is projected at 24 frames per second, then your eyes can only see the on part of the film, not the off, so you see a moving picture, but in actuality, there is no moving picture.

The Discontinuity

> ***"The difference between fiction and reality? Fiction has to make sense."***
>
> *Tom Clancy, American author*

Today, scientists have a good idea as to what's in the "on" part of the signal. It is energy and information. For example, if I take a picture of you with my cell phone and then e-mail it to somebody in China, what goes from here to there is not a picture, but a vibrating signal of photons, *i.e.,* small quantum packets of light or electromagnetic energy. And then the picture is recreated, first in the receiver's cell-phone or computer, and then in his or her consciousness. So, we are using the concept of the discontinuity today in our technology.

The mystery is not what is in the "on" part of the discontinuity, but what is in the "off" part. If you ask scientists at the forefront of quantum mechanics research, *"What is in the off part of the discontinuity," they will tell you the following—there is no energy, no information, no space-time, and there are no objects.* So then, what's there? *The best answer that quantum scientists can give us is that* ***there are infinite possibilities****.* The discontinuity is a field of possibility waves—what Nobel laureate, Werner Heisenberg (Heisenberg's Uncertainty Principle) called the realm of "potentia." It is the immeasurable potential for all that was, all that is, and all that will or could ever be. The details of this almost incomprehensible concept and other aspects of the discontinuity are discussed further in Part II of this essay.

The second point that scientists will agree upon with respect to the discontinuity is that there is a phenomenon called **non-local correlation**. This means that everything in the universe is synchronized, correlated, in harmony and coincidental with everything else. *This correlation is faster than the speed of light. It is instantaneous and it is across space-time where past, present, future and distance in space are all connected instantly. This occurs even when there appears to be no apparent force field between objects.* Some 2,500 years ago, *Buddha called this* ***interdependent co-arising****—everything is co-arising with, correlated with, in harmony with, and synchronized with everything else*. This non-local

correlation effect is responsible for what we call simultaneity in the universe. It appears throughout nature, especially in biological organisms.

Your body, for example, expresses simultaneity and synchronization. It is made up of 100 trillion cells, a number that is more than all of the stars in the Milk Way galaxy, celestial home to our solar system and planet Earth. Each of these cells, measuring less than 1/1000 of an inch in diameter, contains instructions within its DNA that would fill one thousand 600-page books. Each cell performs some 100,000 reactions or activities per second, and every cell instantly harmonizes and correlates its activities with every other cell in your body. And when it doesn't do so with clockwork precision, it means illness, or in some cases—death.

But how does it do this—every second of the day, every day of the year, year after year, until on average, after some 85 years of operation, it just "decides" to stop? For example, how does a human body think thoughts, play piano, kill germs, remove toxins, and make a baby, all at the same time? And while the body is doing all of this, *because of non-local correlation*, it tracks the movements of the stars and planets because your biological rhythms are part of the symphony of the entire universe, which is why we call it the "universe" *i.e.,* "one verse," "one song," and we are all part of that symphony. The incredible beauty of this intelligence seems beyond comprehension. Some call it biological complexity. I think it is at a much higher plane than that. So, the second attribute of the *discontinuity is* ***non-local correlation****, which in metaphysics is synonymous with omniscience, omnipresence, and omnipotence*.

The third attribute of the discontinuity is a **proliferation of uncertainty**, where the laws of nature become uncertain. This means that as we enter the realm of the quantum world or consciousness, the very act of observation or measurement disturbs the system being observed or measured in such a way that it is impossible to ever determine a precise value or number. Furthermore, as we shall see in Part II, in the quantum world, it is impossible to determine when or where a quantum event will occur. Nobel laureate Max Born[1] eventually demonstrated,

[1] A point of trivia—theoretical physicist Max Born was the grandfather of Olivia Newton John, English-born (Cambridge—1948), Australian singer and actress.

all that we can do is calculate the probability of a quantum event occurring. This is in distinct contrast to the classical physics of everyday life, where we can measure things very precisely. So, the classical world is deterministic. Given sufficient information about a given mechanical or chemical system, we can calculate its future *i.e.*, when and where certain events or changes will occur. Not so in the quantum world. When Einstein first heard of the Uncertainty Principle (discussed in Part II), as formulated by a young scientist named Werner Heisenberg, he said, "I don't believe that God would play dice with the universe." But decades later, world-renowned cosmologist Stephen Hawking noted that "Not only does God play dice with the universe, but He throws the dice where you cannot find them."

The fourth principle of the discontinuity is a form of **quantum creativity**, wherein patterns of intelligence, information and energy move from one expression to a new expression in a quantum leap, without a transitional phase. As an example, consider Nobel laureate Niels Bohr's "planetary model" of the atom. Picture the nucleus of an atom, which is the storehouse of protons and neutrons, as being in the same position as our sun, and the electrons as "planets" circumnavigating the nucleus. The negatively-charged electrons provide neutrality to the atom by balancing the positively-charge protons in the nucleus. The electrons are generally distributed in various "orbits," some at higher energy levels, others at lower energy levels. When an electron quantum "jumps" from one orbit or energy level to another, it does so by dematerializing between the two levels. *So first it exists on one level, and then it moves to another, **without ever existing in between the levels**, only to reappear on the second level. Its presence between the two energy levels is forbidden by the laws of quantum mechanics.*

This is not unlike the popular science fiction show, Star Trek, where Captain Kirk says, "Beam me up Scotty." Scotty pushes a button, and the Captain disappears from here, then shows up there, and never appears between. This is a form of creativity that cannot be programmed into a computer because computer creativity is based on algorithms, *i.e.,* a sequence of a finite number of instructions. But true creativity is non-algorithmic; it is a discontinuity. Today, some spiritually inclined physicists say that quantum creativity may be the way that reincarnation occurs. This may be how death serves as the recycling and improvement (evolution) of life. All creativity is in a sense the death of the old paradigm and the beginning or birth of a new one.

Finally, the fifth attribute of the discontinuity that has been demonstrated in quantum mechanics is known as the **observer effect**. First uncovered by the early developers of quantum mechanics, and described in detail by internationally recognized physicist, John Archibald Wheeler, *the observer effect states that the physical universe would not exist if there were not conscious beings looking at it.* Thus unless there is a conscious being looking at the universe, it remains a vibration, a discontinuity. It requires that a conscious being look at this discontinuity and, as the theoretical physicists say, thereby collapse the pertinent quantum wave function[2] from an infinite number of possibilities to one possibility, and somehow mysteriously convert this discontinuity into sound, taste, color, form, smell, *i.e.,* what we call the physical universe.

Wheeler put forth an even more striking proposal concerning the observer effect. He noted that the universe has a number of cosmic constants that are so fine tuned that should they be just slightly smaller or larger, life and the universe as we know them could not exist. An example is Planck's constant, which is one of the smallest numbers we deal with in physics—6.63×10^{-34} *i.e.,* the decimal 0.0 followed by 32 zeros, followed by 663. Wheeler speculates that "Maybe we should approach cosmic fine-tuning not as a problem, but as a clue. Perhaps it is evidence that we somehow endow the universe with certain features by our mere act of observation." This is an idea that Stephen Hawking has been developing as well. Hawking proposes what he calls top-down cosmology, in which we as observers are creating the universe and its history right now. He points out that if this is correct, it is not surprising that the universe is well suited to us.

From what has been said above, *it should be obvious that the discontinuity or vibration is consciousness itself. It's the spirit, and your soul is part of that. Your soul is not a thing. Your soul is a field of infinite possibilities. You soul is the omnipresent, omniscient, omnipotent awareness that is right now orchestrating with simultaneity the hundreds of trillions of things that are happening in your body as*

[2] As discussed in Part II, physical events and/or objects may be expressed by a complex mathematical equation or function—these two words are synonymous here—called the quantum wave equation or quantum wave function. The probability of your making a certain event occur or materializing a certain object is equal to the square of the wave function describing the event. If Ψ represents the wave function for the event, then if you solve for Ψ^2 , you can calculate the probability of your observing that event to occur.

you read this sentence. Your soul embraces uncertainty even though your mind seeks to create certainty. Your soul says, "Let go, detach! There is nothing to worry about." Indeed, this uncertainty is the fertile ground of true creativity, which is infinite. The greater the uncertainty, the greater is the creativity. If something is certain, creativity is non-existent. *And your soul co-creates the mystery that we call God—the Unknown, the Infinite Being, Infinite Consciousness, That which we cannot possibly imagine, because if we could imagine It, then we would limit It. We cannot conceptualize It, because if we could, we would limit It—that infinite, ineffable, eternal, transcendent, Non-Local Consciousness that co-creates with your soul because your soul is part of this Non-Local Consciousness.*

In summary, your soul is a field of infinite possibilities; your soul is omnipresent, omniscient, and omnipotent; your soul embraces uncertainty; your soul is the source of infinite creativity; your soul co-creates with God. This is where we all start from and where we long to return.

Your Soul and Reality

> ***"Put your ear down close to your soul and listen hard."***
> *Anne Sexton, Pulitzer Prize American Poet and Author*

One of the wonderful consequences of the body-soul relationship is that it is quite easy to get directly in touch with your soul. Sit quietly in a room with soft music playing, take several deep breaths and release each one very slowly. Best is to breathe in for five seconds, hold it for five seconds, and then slowly exhale over 10 seconds, repeating this process several times, until you are in a relaxed state. This will relieve any stress. Then become aware of who is listening to the music. Ask yourself, "Who is really listening to this music?" If you feel a pleasant still presence, that presence is your soul. It's not your mind, which might be saying, "What is this guy talking about? Why in the world am I reading this essay?" That's all in your mind, which is a constant conversation, but this mental conversation happens in the presence of your consciousness, which is your being.

In that being, a thought comes, and then it goes. In that being, an emotion comes and then it goes. In that being, a perception of the world comes and then it goes. In that being, your perception of the whole universe comes, and then it goes. In that being, the atoms and molecules that make up your "physical" body come and then they go, because once upon a time you had the body of a child. At that time, you had a different mind, different emotions, and a different personality—hopefully! In that being, the body, the mind, the emotions, the perceptions, the entire universe come, and then they go.

> *"Hold on to that presence; it's the only thing that is real about you. Everything else is the arising and subsiding of [space-time] events in that consciousness. Because it arises, it will also subside. Anything that is of the nature of arising will also subside."*
> *Buddha, Wisdom Traditions*

This is one of the noble truths that we suffer because we identify reality with impermanence. "We better do as much as we can, as soon as we can because it's all over when we die." However, if we go a bit beyond this, we can see that from which it arises, and that into which it subsides has no beginning or ending

in time. So, it is beneficial to be mindful of the arising and subsiding of form, of feelings, of thoughts, of this is me and this is mine, and then by piercing through the vale of all of this, you come to where the eternal ground of consciousness exits and you find Nirvana i.e., the non-dual consciousness where the arising and subsiding takes place.

This conclusion is nothing short of brilliant, mindful, and practical—bringing you into the presence of true reality. This is the window to infinite consciousness in which we all coexist and co-create. We truly are all connected; we have always been and will always be. The impermanence of death is not the end. It's just another step along the way of infinity. When you have the direct experience of this consciousness, not as some kind of moral injunction, but spontaneously, then you will have the deep knowledge and feeling of compassion, of kindness, and ultimately the intoxication of love, which is the source of all healing, all creativity and all manifestations. One of the best kept secrets is that *Love is in fact the greatest power in the universe.*

These simple insights form the basis of Buddha's learning and his teachings. He articulated these insights in what he called the ***Four Noble Truths***. *The* ***First Noble Truth*** *is that every life contains suffering. The* ***Second Noble Truth*** *is that there are reasons for that suffering. The* ***Third Noble Truth*** *is that there is a way out of suffering. The* ***Fourth Noble Truth*** *is that the way out is through what Buddha calls the Eight-Fold Path to Enlightenment. The* ***Eight-Fold Path*** *is a guide to spiritual and intellectual enlightenment with the goal of creating freedom from attachments to, and delusions about the physical universe. The "****Path****" entails seeking and achieving the* ***Right View****, the* ***Right Intention****, the* ***Right Speech****, the* ***Right Action****, the* ***Right Livelihood****, the* ***Right Effort****, the* ***Right Mindfulness****, and the* ***Right Concentration****. From this journey, there arise four profound conclusions:*

1. ***The relative is impermanent****—Everything that arises must also subside.*
2. ***The separate self does not exist****—Our souls are mirrors of each other's souls.*
3. ***Everything is of the nature of inter-being****—We are inter-beings that inter-arise in the domain of "inter-isness."*

4. ***If you can be mindfully aware of the above, you will find a reality that is a non-dual consciousness*** *in which both observer and the observed simultaneously co-arise, as rediscovered in quantum theory, 2500 years after Buddha's formulation of the very same concepts.*

Journey to Well-being

> ***"In the deeper reality beyond space and time, we may be all members of one reality."***
>
> *Sir James Jeans, British Cosmologist (1877-1946)*

All that has been said above can be distilled to 15 principles, any one of which if practiced in a dedicated and mindful manner can lead to a profound transformative experience.[1] *This transformation will enable you to enhance your ability to manifest those things in your life that can lead to your* ***well-being, happiness,*** *and* ***success.***

1. **There are immensely valuable hidden dimensions to your existence, and with practice, you can move into these hidden dimensions.** These dimensions are the realm of your personal soul and the realm of your collective soul, *i.e.,* the realm of universal consciousness. These hidden dimensions exist in a matrix of thought forms because the thought forms that give rise to your personal body and mind are the result of karma, memory and desire. Karma is past experience, memory is a result of this experience, and desire and imagination recreate karma. To embody this principle, take some time each day, close your eyes, put your attention in your heart, picture a bright light pouring in from the universe into your heart, and in this meditative state ask the following simple questions:
    - Who am I?
    - What's my purpose?
    - What do I truly want?
    - What is the contribution that I want to make to the world?
    - What are my unique talents?
    - How can I use my talents to serve my fellow human beings and the planet?
    - Who are my heroes in history, in mythology, and in religion?
    - What are the qualities that I look for in a good friend?
    - What are the best qualities I can display in a good relationship?

[1] These principles are discussed in great depth in Deepak Chopra's, *The Book of Secrets* (Three Rivers Press, New York, 2004).

In asking these questions, do not look for immediate answers. *Live with the questions and in due time, you will move into the answers.*

At this point, a comment on meditation is appropriate as this altered state of being is mentioned throughout this essay as a necessary technique for accessing deeper levels of consciousness. There are two altered states that are relatively easy to access, yet vastly unappreciated by most people because they do not take the time or have the patience to work at achieving them. The first is *passive meditation*, where through a modest level of practice, you disconnect from your active rambling mind by focusing on your breathing or on a single-word mantra. Diligent effort just twice a day for 20 minutes each time can pay huge dividends in helping to achieve well-being and happiness.

The second is *active meditation*, or as Eckhart Tolle has called it, "The Power of Now." In this state, while going about your normal daily routine, you disconnect from your ego-centered mind that wants you to be enmeshed in numerous useless stories, one after another. In your disconnection, you focus *only* on what is happening in the NOW. *i.e.*, in your present—not your past and not your future. Unless you have experienced either of these states of meditation, it is difficult to comprehend their incredible value. For example, when you have succeeded in shutting off ego noise—even for a brief time—and focus only on the present, there is a feeling of bliss that is difficult to describe in words. In either passive or active meditation, the human spirit is at its highest level of creativity. In this state of altered consciousness, your ability to manifest what it is that you want in or out of your life, or to solve the most challenging problems, is at its highest level.

2. **I am not in the world; the world is in me.** I am not in the body; the body is in me. I am not in the mind; the mind is in me. The universe, the world, the body, and the mind are projections of your consciousness. Even though the eyes of the flesh tell you that you are there, and I am here, it's not true. You exist in my consciousness, and I in yours. Without each other's consciousness, we would all be just vibrating energy fields, *i.e.,* unmanifested discontinuities in the "place" of infinite "potentia." We co-create each other in our consciousness. You exist in my consciousness; I exist in your consciousness and the whole

universe and world exists in the same consciousness and the place where I exist in you and you in me is the same place, and it's really not a "place."

It is a field or domain of infinite possibilities—the field of "potentia," as Heisenberg called it (see Part II). The next time you look at a person, say to yourself, "That person exists in me." The next time you see a tree, look at it as your lungs, because if it didn't breathe thereby creating oxygen, you wouldn't breathe, and if you didn't breathe thereby creating carbon dioxide, it wouldn't breathe. Look at the earth as your physical body. It recycles atoms and molecules every moment as our physical body. Look at a body of water and say, "That's my circulation." Look at the atmosphere and say, "That's my breath." And soon you will see that you have a personal body and a universal body, and they are both equally yours. And when you truly see that, you will fall in love with it. And when you fall in love with it, there will be compassion, insight, creativity, love and therefore healing and growth beyond all your expectations.

3. **The path to enlightenment is the practice of yoga.** There are four kinds of yoga.
    - **a.** Yoga of being, which is meditation.
    - **b.** Yoga of feeling, which is love.
    - **c.** Yoga of the intellect, which is the mind and trying to understand how to go beyond the mind.
    - **d.** Yoga of action, which is karma yoga. Karma yoga is a shift in attitude that whatever I do comes from the infinite and it returns to the infinite. Every act, thought, movement comes from the Infinite Being and it returns to the Infinite Being. Thus, I have to do nothing but allow the Infinite Being to channel and express itself through me. So if I'm a salesperson selling a product, I let God make the sale, and I collect the commission!! And it works every time! All you need to do is to truly know and believe that this is the way of the universe.

4. **All fulfillment comes from the creative response of our own consciousness.** No matter what it is you want, you can get it, if you go to the creative response, the intentionality of your own consciousness. *All you have to do is have the intention, get your ego out of the way, be grateful for what you already*

*have, put your **attention** on the **intention**, detach from the outcome, and let the universe handle the details.* This is also the Law of Intention and Desire—the 5th Law of *The Seven Spiritual Laws of Success*.[1] You never have to look outside; the entire process is inside. The best way to do this is through daily meditation, preferably 20-30 minutes first thing in the morning, and 20-30 minutes in the late afternoon, say 4:00 PM. In this state, it is literally possible to achieve anything that does not violate the natural and spiritual laws of the universe.

5. **Acknowledge that life contains suffering, that there is a way out of this suffering, and that the causes of suffering are:**
    - **a.** Not knowing the true nature of the self
    - **b.** Grasping and clinging to that which is impermanent
    - **c.** Fear of that which is impermanent
    - **d.** Identifying with the socially-induced hallucination called the ego
    - **e.** The fear of death

    Through proper practice, diligence and mindfulness; through true perception, *i.e.,* going beyond perception of the five senses, which is the difference between seeing and perceiving, we can find the ultimate reality. Not only can we then go beyond suffering, but we can help others do so, as well. And in doing this, there is no greater gift to others, or to us.

6. **True freedom lies in choice-less awareness.** You can get in touch with choice-less awareness anytime in the midst of the observation when you become aware of the observer who truly is perceiving—your soul. At that incredibly special moment, you are in touch with your source and it is a moment of choice-less awareness.

    Recall the earlier exercise of quietly listening to music and asking yourself, "Who is listening?" In this state, there are infinite possibilities. If you have any intention while in this state, it can unfold and provide full expression of that intention. You can get in touch with choice-less awareness anytime you

[1] Deepak Chopra, *The Seven Spiritual Laws of Success* (Amber-Allen Publishing, 1994).

become aware of the observer in the presence of the observation. The observation is time-bound, but the observer—your soul—is timeless. It always was and always will be. This is freedom to create anything you want in the field of infinite possibilities. *You are endowed with the personal power to make quantum wave functions collapse from an infinite number of possibilities (see Part II) to that single one which is representative of that which you seek to observe and therefore, materialize i.e., your goal.*

7. **The only way to look at the world is to look at it as a mirror.** Every situation, every circumstance, every event, every relationship is a mirror of what is happening inside yourself. Those whom you love and those whom you dislike are also mirrors of you. We fall in love with people in whom we find traits that we desire, and we are repelled by people who have traits that we deny in ourselves. For example, if you tend to procrastinate, you will find that you are impatient with people who procrastinate. The reason is clearly that you are impatient with procrastination within your own life. *If you don't like what is happening in your external world, you simply have to ask, "What shifts do I have to make in my internal world so that the mirror is reflecting a more desirable aspect of me."*

8. **Evil is not my enemy.** Evil is the projection of our collective shadow, all of us on planet earth. The shadow is secret, it's dark; it can be dangerous; it is hidden; it is shrouded in mythology; it expresses itself when there is oppression, when there is suppression of desire, when there is anonymity, when there is bad behavior, when there are passive bystanders, when there is abject poverty, poor conditions, prejudice, us-versus-them leadership, and when many other factors bring out the shadow that then manifests itself as evil—whether it is the Holocaust, Abukir or Guantanamo Prison. *If you want to diminish the evil in the world then get in touch with your own shadow, forgive it, bring the light of awareness to it, share it with someone you trust. Diminish the charge that it brings to the collective shadow in the world.*

9. **We live in multi-dimensions of consciousness and your observation of reality is different in these various states.** Since for every moment of your physical existence here on earth, your state of consciousness creates your

reality, *i.e.,* your perception of the world you inhabit, you can access different "worlds" through different states of consciousness. Unfortunately, many people go through an entire lifetime in a state of low consciousness—nearly unconscious, shuffling between eating, sleeping, dreaming and waking. But this need not be the case, as it wastes your most powerful and gifted asset—your soul. And in doing so, you severely limit your participation in the evolution of the universe, which is your purpose on planet earth.

But, if you take the time to get in touch with the deeper aspects of your being, you can have access to other states of consciousness, what the American poet, Walt Whitman called the "glimpse of the soul," when he said, "I must not be awake for everything looks to me as it never did before, or else I am awake for the first time, and everything before was just a mean sleep." Beyond this glimpse is Cosmic Consciousness. Recall Christ's words, "I am in this world, but not of it"; in quantum mechanics this is known as being local and non-local at the same time (see Part II). Beyond this is Divine or God Consciousness where the objects of your perception can be seen both locally and non-locally. Suppose that when you looked at a flower in your garden you could simultaneously see sunshine and rain and rainbows and earth and water and wind and air and the infinite void in the presence of God—then God would not be difficult to find, God would be impossible to avoid because every object of your perception would be perceived both locally and non-locally.

And beyond this we could potentially experience Unity Consciousness where the witnessing experience and that which is experienced all become one—the observer and the observed coalesce. In this state, it becomes clear that the entire universe is your manifestation. *You have a personal body and a universal body, and they are both equally yours. Knowledge, perception, and reality are different in the various states of consciousness.*

10. **Death is the way to life.** Death is the way the universe recreates and improves on itself. Your body is dying right now so that it can recreate itself. Your stomach cells die every 5 days, but they don't forget in their reincarnation how to produce hydrochloric acid for digestion. Your skin cells die once a month, but they incarnate with the memory of pleasure and pain,

and continue to detect the difference between hot and cold. Our bodies are the incarnation of memory, imagination, desire, and death is quantum creativity. At this very moment, the universe is dying and being recreated at the speed of light, and each time it recreates itself, it improves a bit—it's called evolution. *We die to create a better expression of ourselves*. In biology, "apoptosis" is a term for programmed cellular death. We all experience it. We had better do so! Without programmed cellular death, you would have cancer, which is loss of the memory of death.

11. **Life-centered present moment awareness.** If we successfully conquered death, we would all be living mummies in a fossilized universe, and doomed to eternal senility. "To die unto death," said St. Paul. Let go of the past, it's not here; let go of the future, even though we can imagine it. As Eckhart Tolle brilliantly demonstrates in his best-selling book, "The Power of Now," learning to focus on the present and letting go of the past and the future induces a powerful transition to a state of being that brings immense clarity, comfort and creativity. Tolle profoundly, and I believe rightly, concludes that "You are here to enable the divine purpose of the universe to unfold. That is how important you are!" *It is most important, yet quite straightforward to practice and achieve a state of being that is grounded in the present. We should certainly learn from the past, and also plan for the future, but we benefit most in well-being by focusing on the present.*

12. **Allow the universe to look at itself through you.** At birth every child has the memory of Cosmic Consciousness, *i.e.,* the ability to shift perspective and see oneself from the Cosmic Self. I am an amateur astronomer. One evening, I wanted to impress my 3-year old daughter, Julia, by showing her craters on the moon through my telescope. As she struggled to peer through the lens, and then finally caught a glimpse of the moon's surface in its remarkable splendor, you could see her wheels turning in amazement. She had a difficult time pulling away from the lens. After some reflection, she asked, "Daddy, do you think the moon can feel us looking at it?" *Your eyes are the eyes of the universe looking at itself.* Most of the natural 91 elements were born in neutron stars, many of which exploded in supernovae, seeding the entire

universe with the fundamental building blocks of its construction. *Perhaps, more than metaphorically, the very atoms that make up the molecular structure of your eyes were created so that the universe could look back on itself. This is Cosmic Consciousness, born in every child, more often than not lost in transition to adulthood. Yet through practice, it can be recaptured.*

13. **You will be truly free when you realize that you are not a person.** As Buddha once said, *"There is no such thing as a person." Both the observer and the observed are simultaneously expressed patterns of a deeper consciousness, and we are that deeper consciousness. When you truly recognize this, then you can manifest the person you want to be and also the objects of perception that you want to have as your experience. Daily meditation and continued practice of your focus on the present, i.e., on the NOW in your life is the way to this enlightenment.*

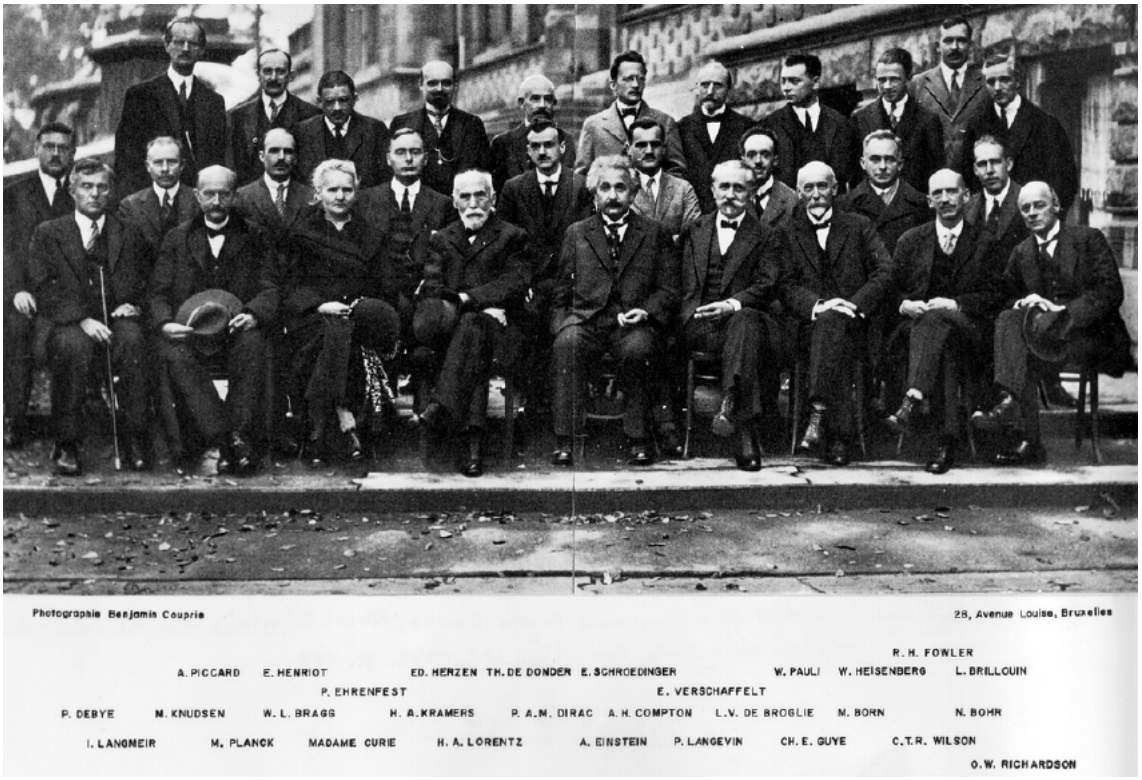
14. **Pay attention to coincidences—synchronicity—as this is truly the mind of God. It is the deeper domain of non-local correlation.** *When a so-called coincidence occurs, contemplate it in a quiet moment and seek to understand it in the context of your life. What is the universe trying to tell you? In asking the question, in a moment of quiet meditation, you will soon move into the answer. There are no coincidences in this universe.*

15. **Find out who you are, where you came from, and what your ultimate destiny is.** *Meditate daily and keep asking these questions until you move into the answers. The very act of this practice is so gratifying. This will not only change your life profoundly, but also the lives of many of those around you. And you will sense this change and welcome it as one of the greatest gifts.*

Focusing mindfully on any one of these 15 principles has the proven power over many millennia to create well-being, happiness, and success in your life. There have been several modern day philosophers, spiritualists and alchemists who have traveled the world throughout the Middle East, the Far East, Africa, and South America in search of the Lost Knowledge—powerful methods that were an integral part of the intelligence, experience and wisdom of our ancient

forefathers, but somehow were lost in translation to our "Modern Civilization." These 15 principles, in one form or another, permeate the fabric of this Lost Knowledge. One or more of these principles may especially "speak" to you. If so, I suggest that you grab hold of it. Focus on it. Practice it. Be patient. The rewards are extraordinary!

Part II
A Primer on Conscious Quantum Mechanics



Solvay Conference on Quantum Mechanics—1927

"Observations not only disturb what is to be measured, they produce it."
Pascal Jordan, Developer of Modern Quantum Theory

"I have thought a hundred times as much about the quantum problem as I have about general relativity theory."
Albert Einstein

A Profound Perspective

> ***"I like to think the moon is there even if I am not looking at it."***
> *Albert Einstein*

Quantum mechanics has revolutionized our world, and it continues to do so. Whether you use a cell phone, surf the internet, have laser surgery, listen to a CD or watch a DVD on TV, you are intimately dependent on the power of quantum mechanics, as is 30% of our global economy. This area of physics is also likely to revolutionize computing in the form of quantum computing and quantum cryptography. What is so fascinating about quantum mechanics is that you can be highly trained and skilled in the mathematical and physical methodologies necessary to use the subject in a practical and constructive manner, and yet if you truly confront the meaning and implications of quantum mechanics, it can be quite discomforting in the context of what we perceive to be the "real" world. It brings science face-to-face with metaphysics, and that's incongruent with the basis for the scientific method and not pleasant for modern-day scientists, considering the manner in which they conduct 21st century science.

Think for just a moment about how much funding a university physics professor might receive for a research proposal submitted to the National Science Foundation and entitled, "The Impact of the Individual and the Collective Soul on Quantum Processes." Or perhaps consider how the audience at a National Physical Society meeting might react to a question during the discussion period about how spirit might have influenced an experimental result involving quantum processes. Would an assistant professor have any chance of getting promoted to a tenured position if the professor's research embraced the interface of consciousness and quantum mechanics?

Before considering the implications of this conundrum, and its potential to significantly improve your life and well-being, it is useful to review a few physical concepts that will be used along the way. For a preliminary understanding of basic quantum phenomena, we can consider the oversimplified classical "planetary" model for the atom, initially proposed some 80 years ago by one of the founding fathers of quantum mechanics, Danish Nobel laureate, Niels Bohr.

Picture the nucleus of an atom in the centric position of our sun. It is positively charged and composed of neutral "particles" called neutrons and positively-charged protons. The neutrons and protons are made up of subatomic "particles" known as quarks, leptons and bosons; however these subclasses are not immediately pertinent to our discussions here. The positive charge of the protons in the nucleus is balanced to neutrality by an appropriate number of electrons spinning around the nucleus, much the way the planets in our solar system revolve about our sun.

The electrons spinning about the nucleus can change energy levels (orbits) by interaction with a variety of forces, including photons, which are the basic particles or packets of light, or more precisely, of electromagnetic radiation. For example, a low energy electron circumnavigating the nucleus in say a "Mercury" orbit close to the "solar nucleus" can be excited or stimulated by a number of methods to "jump" to a higher energy orbit, say the "Jupiter" orbit. Or the reverse can occur, an electron can "jump" from the "Jupiter" orbit down to the lower energy "Mercury" orbit with a consequent emission of energy, usually in the form of a photon. Using this model, often called the "Old Quantum Mechanics," we can describe a number of useful conclusions based on *the laws of quantum mechanics, which in more than 100 years have never made a wrong prediction.*

But to dig deeply into the metaphysics of quantum theory, we must make the transition to the New Quantum Mechanics, as developed in the mid-1920s by Werner Heisenberg, Erwin Schrödinger, and other theoreticians. We will describe both of these models a bit later. However, a word of caution and clarity—despite the practical effectiveness of quantum mechanical models, most physicists believe that atoms, electrons, neutrons and protons are not solid particles, as these models might imply. They are more precisely, packets of information and energy. That being said, quantum mechanics can explain numerous properties of what we, with our five senses, perceive to be the stuff of our universe. More important, and perhaps quite surprising, it can provide you with a more accurate perspective of your true reality, and thereby give you specific tools that can significantly enhance your quality of life and well-being. As we shall see, this is by no means any kind of "hocus pocus," but is based on the proven results and implications of experiments and models at the interface of quantum physics and our true reality.

In all that follows, almost no mathematics and only elementary concepts in physics will be used. This means that nearly every statement is offered to the reader as an article of faith. If you were willing to learn the advanced mathematical tools and become facile in the pertinent areas of modern physics, I believe that you would likely agree with the conclusions that follow. I also feel that a number of physicists—but clearly not all—would not take exception to what follows, although most would be uncomfortable with the conclusions.

We will touch on the following profound phenomena. They distill directly from modern quantum theory:

- **Observer Effect**—*What you perceive as your reality is actually something you create by your observation of the universe.* When you "consciously" observe something under a given set of circumstances, an event occurs and/or an object appears. This event and/or object are directly created by you, the observer. Before your observation, the event and/or object was simply a state of energy vibrating in an infinite domain of potential or possibilities. It is your observation that causes the specific possibility to materialize. This effect has been shown experimentally for subatomic particles, atoms, and more recently for large molecules. Quantum mechanics tells us that although it may not be possible to do the same experiments for large objects such as people, since such objects are composed of atoms and molecules, the same conscious creation of these objects is what occurs in what we perceive with our five senses to be reality. *In other words, you are constantly creating what you perceive.*

- **Infinite Possibilities**—*What actually exists "out there" is an infinite number of "possibilities," in a domain that physicists refer to as the domain of "potentia."* This infinite number of possibilities can be described by a complex mathematical expression called the quantum wave equation or quantum wave function, where you can think of the wave function as "spread out infinitely" over all of the possible outcomes. The probability of you perceiving a given outcome, namely, a certain event or the existence of a specific object under a given set of conditions, can be calculated from the square of the wave equation. When you create a certain event by your observation,

mathematically speaking, we say that you have caused the wave equation to collapse from an infinite number of possibilities to a specific possibility or result.

World-renowned physicist and Nobel laureate, Eugene Wigner, speculated that observation and instantaneous collapse of the wave function happens at the very last stage of the observation process, perhaps when awareness occurs. He also speculated that human conscious awareness might actually "reach out" in some unexplained manner and change the physical state of a system. All we know at this point in time is that somewhere on the scale between subatomic particles, atoms and large molecules, and that of big objects such as cars, buildings and human beings, there is a mysterious unexplained process wherein observation collapses the wave function to a specific possibility and observation. And voilà, there it appears!

- **History Creation**—*For decades, quantum mechanics predicted that your observation not only creates your present reality, but also creates the past history appropriate to that reality, i.e., you actually produce something backwards in time.* Most scientists found this difficult to comprehend, much less believe. Quantum cosmologist John Archibald Wheeler suggested what he called a "delayed-choice experiment," which if carried out would determine whether or not one's observation actually could produce something backwards in time. For a long time, this was just conjecture, but in 1987, the experiment was performed and it confirmed that backwards-in-time history is created by the observer. Scientists still find this difficult to comprehend or believe. However, Einstein would remind us that time (and space) are convenient parameters created by scientists to understand the nature of the universe. They are not absolute entities.

- **Entanglement**—Small particles such as electrons, atoms and molecules experience a mysterious effect called "entanglement," wherein a change in one particle instantaneously affects another particle at a significant distance, even though there appears to be no force field between the two particles. For example, it is possible to have two electrons, proximate to each other that are paired together, one spinning to the left, and the other spinning to the

right. If these electrons are now separated by hundreds of kilometers, and then the spin on one is reversed, the other instantly reverses its spin as well, as if it "knew" when and what to do! *The communication between these two electrons takes place instantaneously and superluminally, i.e., immeasurably beyond the speed of light.*

All experiments to date suggest that this same effect would occur if these electrons were galaxies apart, separated by millions of light-years. The communication would still be instantaneous and immeasurably faster than the speed of light. How this communication occurs is still a mystery to physicists, as no apparent forces are involved. Albert Einstein who discovered the special and general theories of relativity and helped launch the quantum mechanical revolution, was deeply disturbed by this phenomenon which he called "spooky action at a distance." It threatens the very essence of his relativity theory, wherein information traveling faster than the speed of light should not be possible. *In a moment of truth, some physicists will tell you that there is absolutely no reason to believe that the same kind of effects would not occur for things larger than an electron, such as a human being.*

- **Teleportation**—*A fascinating and proven consequence of entanglement is that essential information contained within one of two entangled entities, e.g., two photons, may be transmitted instantaneously, over a distance that could just as well have been millions of light years, materializing in the form of a third photon identical to the first. The initial photon simultaneously vanishes in the teleportation experiment as if it had moved through "nothingness" from "here" and showed up "there" as the third photon. Teleportation has been demonstrated for electrons, atoms, and molecules.*

- **Duality**—*Depending on how we measure the properties of an entity such as an electron, a neutron or a photon, they appear as both particles and waves.* This attribute applies to big things such as human beings as well, although it is impossible to do the experiment for such large objects to prove this fact. This is the so-called duality of quantum mechanical measurement. As we will see in discussing this phenomena, there are proven profound conclusions difficult to believe in our macroscopic world.

- **Two Places At Once**—If there is one electron, or photon, or neutron, or atom, or many other entities and two boxes in a given system, there is a calculable probability that the entity will be found in one of the boxes. *Before you pick up either box to look inside, the entity is actually present in both boxes, and it is your looking that collapses the wave function and allows you to find it in one of the boxes.* In fact, you can calculate from the square of the wave equation the precise probability that you will find the entity in one of the boxes. The probability is directly related to the "waviness" of the wave equation. The "wavier" a set of conditions in the wave equation, the higher the probability of you finding a selected object in a chosen place.

  An important fact: *The waviness or the square of the wave function is the probability of you **finding** a selected object, say an electron in a given place. It is not the probability of the object **being** in the chosen place.* The object is actually in both places until you look and find it in one place. You produce it there by your observation. Unlike the classical shell game, where the pea is in fact under one of the walnut shells, quantum mechanics says the atom's (or any other small entity's) "waviness," and therefore the atom itself, is simultaneously in both boxes. Observing one of them, and finding it there, collapses the wave function and produces the atom in the single box where you find it.

- **Big Is Like Small**—*Even though quantum mechanics is absolutely necessary to describe the state of being for small objects like electrons, neutrons, and photons, it applies to everything—you, me, the planet, the entire universe.* In fact, cosmologists struggle with writing the wave equation for our universe. The reason is that the universe is made up of these same entities that obey the laws of quantum mechanics. It is just difficult to see the same profound effects when things get big. *However, even with big things, we create our own reality.*

- **Uncertainty Principle**—According to Nobel laureate Werner Heisenberg, small or microscopic objects such as electrons and atoms are not "real" in our everyday sense. They exist as "potentialities," and hence what we call the domain of "potentia," where there exist infinite possibilities and one of them is created by the collapse of the wave function to a specific state or

set of conditions, as a consequence of our observation. Heisenberg proved mathematically that any observation disturbs things enough to prevent disproval of quantum mechanic's assertion that observation creates the property observed. *Stated another way, the more accurately you know the exact position of a moving particle, say an electron, the less accurately you know its velocity, and conversely.* This same principle applies to large objects, but the calculated uncertainties are so small as to be immeasurable. Because of this, we need only use Newton's laws or Newtonian mechanics as opposed to quantum mechanics to track spaceships, satellites and planets. Newtonian mechanics is an approximation or simplified form of quantum mechanics.

- **Quantum Jumps**—In an atom, negatively-charged electrons can be considered to be whirling about the atom's positively-charged nucleus, occupying different energy levels or orbits. There are many ways to stimulate an electron to jump from one energy level or orbit to another, either to a higher or lower level. This movement is called a "quantum jump." In the process, the electron is initially present at say energy level 1, and then jumps to energy level 2. Before and after the jump, it can be observed at each of these respective energy levels. *However, during the quantum jump process, it exists nowhere in between. Quantum mechanics forbids its existence between the levels.*

- **Electron Promiscuity**—The electrons around the immediate diameter of an atom spend more than 95 percent of their time within a tight radius about the nucleus. However, there is a small, but finite probability that these electrons can be found anywhere in the universe. Technically speaking, we are all intimately sharing our electrons with each other, and in fact with all matter in the universe. There is a probability of electron contact with everyone from Julia Roberts to a gorilla in Uganda!

The above statements are absolutely correct. If you are confused and/or disturbed by them, you are not alone. For decades, most physicists have chosen not to deal with these "realities." The reason is obvious—it brings physics face-to-face with metaphysics, and that would not be good for a physicist's reputation—or research funding.

However, as research advances in the important emerging areas of quantum computing and quantum cryptography, there is no way not to encounter these issues. In fact, the technical basis for these new fields is precisely predicated on these unusual properties and phenomena. Just as most governments preach separation of church and state, most physicists hold holy the separation of science and philosophy, and especially science and spirituality. After all, that schism was painfully, but very effectively, made during the Inquisitional period of the Middle Ages with the birth of the scientific method and the separation of physics from philosophy and spirituality or consciousness.

To put some of these profound conclusions in a hopefully clearer context, let's review the history of the development of quantum mechanics, albeit for convenience and practicality, in a non-mathematical manner.

A Brief History of Quantum Mechanics

"It is safe to say that nobody understands quantum mechanics."
Richard Feynman, Nobel laureate and Creator of Quantum Electrodynamics

Our story begins in 1801, when the English polymath, Thomas Young conclusively demonstrated that light behaves like waves and not as particles, as suggested earlier by Isaac Newton. Although this had been speculated in the 17th century by a Dutch scientist named Christiaan Huygens, it was Young who proved the point beyond a shadow of doubt. The key to Young's discovery is what are called interference phenomena. Young found that when sunlight is passed through two closely adjacent thin slits cut in a piece of paper, it projects alternate dark and light concentric rings on the surface of a projection screen. As shown in **Figure 2**, these results are readily explained if light is wave-like in nature—similar to the ripples created by a stone tossed into a still pond. If the waves from each slit arrive at the surface in phase, that is to say if the peaks of the various waves coincide with each other, then on the projection screen you see maximum reinforcement or "constructive interference" as indicated by a light band or area. However, if the light waves arrive out of phase (the peak of one wave coinciding with the valley on another), then you see cancellation of the light wave's intensity and therefore a dark area, caused by cancellation of the wave or "destructive interference." This is why we call these projections, "interference rings or fringes." Young's work proved that light had to be wave-like in nature. There was absolutely no other interpretation possible.

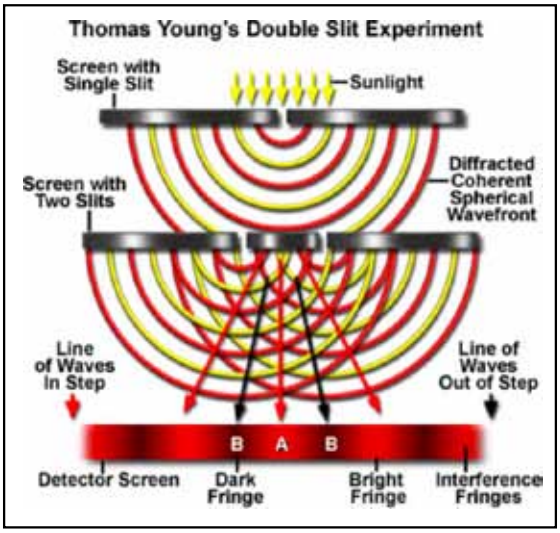
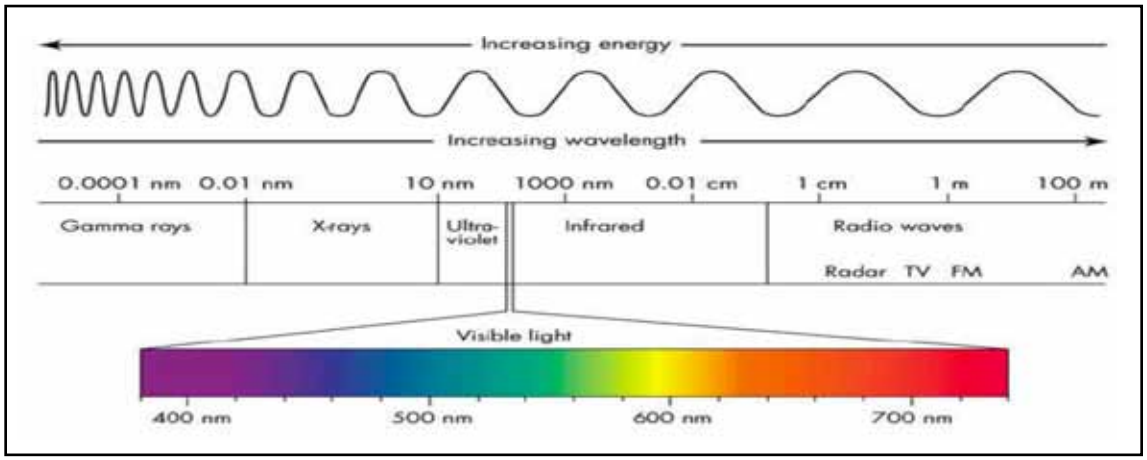


Figure 2: Thomas Young's Famous Double Slit Experiment

As time progressed in the 19th century, the self-taught chemist and physicist Michael Faraday demonstrated that an electric current that changes with time generates a magnetic field perpendicular to it, and conversely a magnetic field that changes with time generates an electric field perpendicular to it. However, it was the mathematical genius of James Clerk Maxwell, who took Faraday's results and produced Maxwell's Equations, four of the most important equations in modern classical physics. One of these equations demonstrates how a changing electric field creates a magnetic field; this equation also enables us to calculate "c," the velocity of electromagnetic waves. This value turns out to be precisely the speed of light, about 300,000 meters/second or 180,000 miles/second. Therefore, light, and electromagnetic radiation in general, certainly must be transmitted as waves. We can picture the most common examples of the electromagnetic radiation spectrum proceeding from very long wavelengths, low vibrational frequencies and low energies to very short wavelengths, high vibrational frequencies and high energies, as follows:



nm = nanometer *i.e.,* 10^{-9} or 1 billionth of a meter m = meter

Figure 3: Electromagnetic Spectrum

* * *

All of the implications summarized above in the section entitled, "*A Profound Perspective*," came about as a consequence of the development of quantum mechanics during the period 1920-30. But the genesis of quantum theory actually began in 1859 when Gustav Kirchhoff proved an elementary theory about what is called blackbody thermal radiation. A blackbody is a substance that absorbs all of the electromagnetic radiation that falls upon it and therefore does not reflect any radiation back, so when dealing with the visible part of the electromagnetic spectrum, an observer would see it as a black object since no light would be emitted from it. However, if you heat the blackbody to a given temperature, it will emit blackbody radiation, characteristic of that temperature. In the laboratory, blackbody radiation can be generated using a small oven, heated to an even and constant temperature. The oven should have a small aperture through which thermal radiation for a given constant temperature is emitted. As the temperature of the oven is changed, the intensity and vibrational frequency of the thermal radiation also changes to that characteristic of the temperature.

Kirchhoff assumed correctly that thermal radiation was wave-like in form and he showed that emitted blackbody radiation energy should depend on the temperature (T) of the object that was emitting it and the vibrational frequency (ν) of the emitted thermal radiation. The vibrational frequency (ν) of the radiation is inversely proportional to its wavelength (λ), and is a measure of how many times per second a wave vibrates or modulates from its peak to its trough, or low point. In fact, for electromagnetic radiation, the vibrational frequency (ν) is calculated precisely by dividing the speed of light by the wavelength of the specific radiation, *i.e.,* $\nu = c/\lambda$. Kirchhoff was not mathematically adept enough to derive the specific formula for the dependence of blackbody radiation on temperature. He challenged his theoretical physicist colleagues to come up with the correct formula.

In 1879, Josef Stefan carried out some experiments and proposed that the total energy emitted by a hot blackbody source of thermal radiation should depend on temperature to the fourth power, *i.e.,* it is proportional to T^4. Ludwig Boltzmann showed the same relationship, using thermodynamics and Maxwell's theory of electromagnetic radiation. The relationship known as the Stefan-Boltzmann law was not the final answer as it did not work for all frequencies or wavelengths of thermal radiation.

Then in 1896, Wilhelm Wien proposed a mathematical relationship that worked for small values of wavelength (λ), *i.e.,* high frequencies (ν), but was shown by Heinrich Rubens at the University of Berlin not to work in the far-infrared range or low frequencies, *i.e.,* long wavelengths.

Kirchhoff, who was a professor at the University of Heidelberg, was awarded a new post in Berlin. His position was offered first to Boltzmann and then to Heinrich Hertz, but both famous physicists turned down the offer. The position was reluctantly presented to an unknown physicist named Max Karl Ernst Ludwig Planck, better known as Max Planck, who accepted it. Planck had been told by many members of his family and friends not to go into physics as there really was not much left to discover, and therefore, there wasn't much of a future.

On Sunday, October 7, 1900, Rubens, a former colleague of Planck, visited with him and told him of his findings concerning Wien's work. Several hours after Rubens left Planck's home, Planck successfully guessed the correct formula to explain the radiation emitted from blackbodies at all frequencies or wavelengths. Not satisfied with guessing the answer, he tried to uncover the theoretical basis for the formula. He tried many approaches, all of which failed, and then in a moment of sheer desperation, he made an unprecedented—some at that time would say "absurd"—assumption, which would change the world of physics forevermore. *This modest, conservative, relatively unknown theoretician assumed that the total energy emitted by a blackbody was composed of indistinguishable packets of energy elements called "quanta," later renamed, "photons."*

This basic mathematical assumption was simple, yet profound. Planck assumed that the energy, E, for the quanta or photons was given by the deceptively simple formula: $E = nh\nu$, where h is a constant, later named Planck's constant, ν is the vibrational frequency of the quanta (the number of times per second the quanta vibrate back and forth), and n is an integer (1, 2, 3, . . . etc.). The fundamental and creative leap here is that the energy can change only by integral amounts (1, 2, 3 . . . etc.), photons or packets of energy at a time, not as a continuous source of energy. So no energy was permissible for say n = 1.5, or any other non-integer number. Planck speculated that perhaps these quanta were somehow emitted from the vibrating surface of the blackbody. He admitted later that his

assumption of quanta, for which he would later win the Nobel Prize in Physics "was indeed an act of desperation."

In 1905, along came a patent examiner third-class named Albert Einstein, who could not find a job practicing physics in a university. He wasn't considered experienced or able enough to be a physics professor. His extra time at the patent office gave him the opportunity to think and imagine, which was his very nature, and that same year, often called his *annus mirabilis*, or "miracle year," Einstein published three papers that eventually changed the face of physics. One of them was about a phenomenon known as the photoelectric effect, which is the release of electrons from the surface of metals when the surface is bombarded with light; this paper immediately launched the rapid development of quantum mechanics. The other two were on the special theory of relativity and a mathematical explanation of Brownian motion, thereby conclusively demonstrating the existence of molecules, which at that time were only speculated to exist.

Maxwell's theory of electromagnetic radiation, which assumes that light is a wave, gives results that conflict with Einstein's interpretation of the photoelectric effect, which implied that light is composed of particles. Metals contain electrons that can move about within the atomic structure of the metal. This is how an electric current propagates within a copper wire. However, the electrons don't have enough energy to escape from the metal surface. In the photoelectric effect, light of sufficient energy, usually in the ultraviolet range, hits an electron and transfers enough energy to help the electron escape the forces holding it within the metal. According to classical physics, electrons would be excited by the ultraviolet light "waves" and some could become sufficiently energized to jump out of the metal surface. In this classical way of thinking, the degree to which the photoelectric effect took place would be expected to depend on the intensity of the light beam, since this is directly proportional to the energy of the light beam—the brighter the beam, the higher the energy.

So, if you wanted higher energy electrons, classical physics predicts that you should simply shine a brighter or more intense light on the metal surface. You would never expect that there would be any dependence on the frequency (ν) or wavelength (λ) (recall that $\nu = c/\lambda$) of the incident light. However, what occurs is

exactly that. Below a certain critical frequency, no electrons are emitted, no matter how intense or energetic the light beam is, and above this critical frequency, even a very weak light beam can eject electrons.

Einstein, aware of Planck's work which assumed that light was delivered in quanta, made the same assumption in his work on the photoelectric effect (*i.e.,* E = nhv) and was able to accurately derive an equation to describe the dependence of energy of the electron emitted from the metal on the frequency or wave length of the incident light radiation. Later these quanta were renamed "photons." *In fact, the mathematical expression that Einstein derived contained the exact same constant that was present in Planck's expression for blackbody radiation. It became known as Planck's constant (h) and is a fundamental cosmic constant of our universe.* It is a very, very small number (6.6×10^{-34}, that is the decimal 0.0 followed by 32-zeros and then 66), but it is so fundamental that if it were slightly higher or slightly lower in value, life and the universe as we know them could not exist.

Now physics faced a crisis. How could all of the fundamental discoveries of the 19th century, such as those of Young and Maxwell, which depended on light being a wave, now be explained if light is a particle, *i.e.,* small quantum packets called photons? How could both of these models be correct? *The fact is that they are, and on this bedrock rests a fundamental concept in quantum mechanics called wave-particle duality.*

Am I a Wave or a Particle?

> ***"The entire 50 years of pondering have not brought me closer to an answer to the question, 'What are light quanta [photons]?' Today, every Tom, Dick and Harry believes that he knows, but deceives himself."***
>
> *Albert Einstein, at age 72 (1951)*

Consider the following experiments, which have been done many times by numerous investigators. Let's refer to our previous **Figure 2**, in which Thomas Young's double slit experiment shows that light is a wave. On the second screen which has two slits, let's call the slit on the left Slit A and the one on the right Slit B. If instead of a light source we were to fire large-scale particles such as bullets or marbles at a sturdy thick metal screen containing Slits A and B, we clearly know what would happen. A distinct pattern would result on the detection screen, immediately behind each of the slits, indicating whether the particles went through Slit A or Slit B.

Now, instead of creating a source of light by putting sunlight through the single slit that precedes Slits A and B, as Thomas Young did, let's replace this slit with an electron gun, an apparatus that can fire electrons at the screen containing Slits A and B, millions at a time, or if we adjust the gun, just one electron at a time (see **Figure 4**). As in the case of Young's sunlight experiment, the electron gun is located midway between Slits A and B. Beyond Slits A and B, instead of a simple screen that showed an interference fringe pattern when light was diffracted through Slits A and B, we now place an electron detector. This could be a photographic plate on which a colliding electron makes a mark on the photographic plate. Next, the rate of electron delivery from the electron gun is adjusted so that only a single electron is fired towards the screen containing the two slits at any given time. What happens?

Single electrons arrive at the photographic plate one by one, and for each electron there appears on the plate a corresponding mark indicating it has been struck by the electron. This shows that the electron behaves as a particle, since only one electron produces a single mark on the photographic plate. *However, after we fire many electrons, one at a time, at the screen containing Slits A and*

B, we find an amazing result. We see an interference pattern, the characteristic signature of waves, created exactly as Young had seen for sunlight!

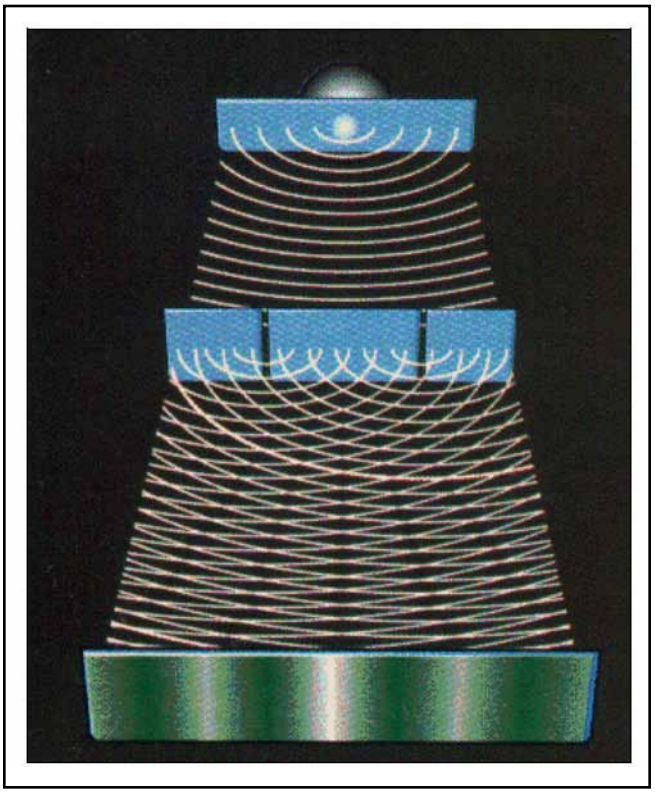


Figure 4: Electron Bombardment of Double Slits

As shown in **Figure 4**, there is an intense line on the photographic plate just opposite the point midway between Slits A and B, corresponding to the location where the largest number of electrons has hit the plate. On either side of this dark spot or central band, alternating light and dark bands appear, both diminishing in intensity as we move from the center out to either side. This, of course, corresponds to the non-arrival and arrival of electrons at these positions, respectively. This so-called interference pattern, which is exactly what Young had seen with sunlight, is clearly the unmistakable signature of waves. Electrons must not only behave as particles but also as waves! When they arrive at the photographic plate, one by one, they produce the signature of a particle on the plate. However, after many electrons have arrived at the photographic plate, even though it has been one by one, the signature is that of a wave pattern. Actual experimental data are shown in the figure in Appendix I.

There is an even more subtle, but profound implication that follows from this electron double-slit experiment, and it is that this observation provides a glimpse of what lies at the very heart of the difference between classical physics and quantum physics. Consider the following. When a single electron is fired from the electron gun and travels towards the screen containing Slits A and B, through which slit does it pass in order to get to the photographic plate? Suppose it went through Slit A. In that case, Slit B would be unnecessary and we could just as well have closed it. But, with only Slit A open, the electron would not be most likely to arrive at the midpoint of the photographic plate exactly midway between Slits A and B as it does, but instead would end up at the point on the photographic plate exactly opposite Slit A. Since this is not the case, we can conclude that the electrons could not possibly have gone through Slit A. If we make the same argument for Slit B, we see that the single electron could not have gone through Slit B, either! What's happening here? *The answer is that the single electron has gone through both slits at the same time!* How could this possibly be? Does the electron interfere with itself as light waves do?

Physicists decided to do the electron experiment again and this time to put a detector immediately on the other side of the two slits to see which slit the electron was actually going through. However, when they "peeked" by doing this, the experiment returned to the results observed when an electron acted as a particle and a pattern was seen only opposite each of the slits. No interference pattern formed. *It was as if the electron "knew" that the experimenter was peeking, and it "decided" to go back to particle-like behavior.*

Our general sense of reality, conditioned by classical physics and our five senses says that this is nonsense, but it isn't. In quantum mechanics, we refer to this phenomenon as the superposition principle, and it makes perfect sense. It means that the state of motion of the electron has a probability of going through Slit A and a probability of going through Slit B, and the final result on the photographic plates is the sum, or in quantum mechanical language, the superposition of these probabilities. It is only by our observation that we "collapse" the wave function describing the system and the probability to a specific result. In essence, there are various probabilities before we observe the system; however, the very act of observing collapses the wave function to a specific possibility. *In truth, our observation creates this reality.*

In fact, the superposition principle demonstrates three aspects of quantum mechanics that appear to most of us to be in the realm of mysticism. *The **first point** is that at our current state of human development and reality perception, it is impossible to form a clear picture in terms of our five senses about what is happening in the course of the physical process.* We could not possibly visualize how an individual particle, such as an electron, a photon, or even an atom could simultaneously go through both slits. The **second point** is the probabilistic nature of quantum mechanics, in that unlike the perfectly certain world of classical physics, it is no longer possible to predict what will happen when we make an observation. The deep philosophical and actual point here is that classical physics is deterministic and quantum physics is probabilistic. In classical physics, if I throw a ball up in the air, knowing all of the forces on the ball, and using Newton's laws, I can tell you exactly where the ball will be at any point in time in the future; classical physics is deterministic. Not so in quantum physics. I can only tell you the probability of finding the object at a given point at a given time. *The **third point** is that your observation actually creates your reality!*

To demonstrate this point, suppose we were to modify the double-slit experiment by putting a photographic plate detector immediately on the other side of Slit A and Slit B, so that we could determine which slit the electron passed through. What we find in this modification of the experiment is that sometimes the electron is detected near Slit A and sometimes it is detected near Slit B. It is impossible to predict which slit the electron will go through, but over a large number of electron firings from the electron gun, we find that the relative probabilities of going through each slit is 50-50. This illustrates that in quantum mechanics, predictions of the results of measurements are always statistical in character and not deterministic as in classical physics. After all, if we were firing a bullet through Slit A, we know that every single time we fire the gun at Slit A, the bullet will exit Slit A. *Quantum mechanics deals in probabilities and not in certainties.*

A final point concerning this modification of the experiment is the destruction of the interference pattern on the photographic plate. No longer do electrons tend to the midpoint of the photographic plate, but are split evenly between those arriving opposite Slits A and B. This demonstrates that whether we see particle-like or wave-like behavior depends on what we look for. *If we ask a particle-like question (which slit is the electron going through?), we get a particle-like answer.*

If we ask a wave-like question, (What is the final pattern of all of the accumulated electrons?), we get a wave-like answer. In many respects, the double-split experiment embraces all of the mystery, essence, and power of quantum mechanics. In 1926, physicist, Max Born developed the quantitative interpretation of the probabilistic nature of quantum mechanics, for which he received the Nobel Prize 28 years later, in 1954.

The superposition principle was of deep concern to Schrödinger, Einstein and other founding fathers of quantum mechanics. Schrödinger often said that had he known about this outcome, he would never have had anything to do with the development of quantum mechanics. He said this even after receiving the Nobel Prize in Physics. To elucidate his concern over the superposition principle, he created his famous Schrödinger cat thought experiment. In this "horrid" experiment, as he like to call it, he envisioned a sealed box containing a cat, a glass flask of hydrogen cyanide, a radioactive atom (*e.g.,* uranium), a Geiger counter, an electric relay and a hammer. When the atom of uranium decays, the Geiger counter detects the emitted radiation and sends a signal that activates the relay, releasing the hammer, smashing the flask, releasing the cyanide, thereby killing the cat.

Radioactive decay is a quantum process, and therefore using Max Born's methodology, we can calculate the ***probability*** of the uranium atom decaying at any given time. Whether it has actually decayed at that instant and therefore whether the cat is alive or dead is not precisely known—we only know the ***probability*** of occurrence—at least until we peek into the box. According to quantum mechanics, the cat exists in two states of superposition—dead and alive—that is, it is both dead and alive at the same time until we look to find out. At that very moment, the wave equations for the dead and living cats collapse, and we know precisely whether the cat is alive or not. By looking, we create the final event. Schrödinger was trying to demonstrate the paradox of the superposition principle, which in nearly 70 years since modern quantum mechanics was first formulated, has never been found to be incorrect. Of course, to date, the theory has been applied to small entities such as electrons, photons, atoms and molecules, never to a living system.

However, currently Drs. Ignacio Cirac and Oriol Romero-Isart, two researchers at the Max Planck Institute for Quantum Optics in Garching, Germany, are planning to do the Schrödinger experiment with a "living" system.[1] It must be small, so they have chosen a virus. By pulsing the virus with a laser under certain controlled conditions, they can create a situation where the virus is present both in a ground state and an excited state. They then plan to demonstrate observation of the virus as being simultaneously in both states, and therefore the reality of superposition principle for this microbe. Then, by "looking," the wave equation for these two states should collapse and only one of the states should be observed. Some may argue that a virus is not "alive," so if they are successful, they will move on to tardigrades, a small living arthropod.

[1]"Schrödinger's Virus," *The Economist*, October 3, 2009, p. 92.

The Atom—What Am I?

"In every atom, there are worlds within worlds."
Yoga-Vasistha, Ancient Sanskrit Poem

It is currently reasonably well established that the birth of our universe occurred about 13.7 billion years ago. Without delving into the details of the nuclear and particle physics involved, we can simply note that eventually with the formation of stars through the agglomeration of hydrogen, helium and lithium nuclei that existed in primordial space as a consequence of the "Big Bang," larger atoms were eventually formed within these stars. Many highly-compacted, high-density stars under super-high pressures created the additional naturally occurring elemental atoms through a series of complex nuclear fusion and fission reactions, and then exploded as supernovae, seeding the universe with the naturally occurring elements that we now find on planet Earth. So, it's not just a metaphor of poetry that we and everything that exists on earth were made from "stardust"; it's a fact of cosmology.

Today, our best estimate of the "stuff" of the universe is 70% dark energy, 25% dark matter, and 5% matter that we can "see" with our five senses, such as the earth, the planets and the stars. Keep in mind that when we say dark energy, we do not mean that energy is a "thing"; it's not. Energy is actually an attribute of something. That is to say that the so-called dark energy of our universe is a characteristic of something "out there" that has that much of the universe's energy associated with it. Although to be sure, we know from Einstein's famous equation, $E=mc^2$, that energy can be converted into matter and conversely. But now let's come back down to earth and return to the ordinary atom.

Although J. J. Thompson discovered the electron a little over 100 years ago in 1897, the concept of the atom was not very well accepted at the end of the 19th century until Ernest Rutherford performed an important experiment in 1911. Up until that time, the picture for the atom was called the "Plum Pudding" model, basically a cloud of whirling negative electrons, with positive protons dispersed throughout the cloud like plums in a plum pudding, or rather in an "electron pudding," thereby providing a neutral balance of charges.

However, Rutherford found that when he fired alpha particles (positively charged helium atoms) through a gold foil, every once in a while they bounced back as if they had hit a brick wall. The protons, he concluded, must be concentrated in a very small area, which he called the nucleus. Rutherford suggested that rather than plum pudding, the atom was more like our solar system. The central role of the sun was played by the nucleus made up of positive protons, and the electrons were envisioned as planets circling the nucleus in various concentric orbits. The nucleus also contains neutrons, particles with no charge on them, but their discovery by James Chadwick had to wait until 1932. The Rutherford atom seemed to fall in place quite nicely.

Although Rutherford was a first-class experimentalist, he was not well versed in theoretical physics. As a consequence, there was one major problem with his model of the atom. If electrons are negatively-charged particles that are continuously circling the nucleus (also pictured as a larger particle) like planets around the sun, it means that the electrons are continuously changing their direction of motion, as any object moving in a circle does, which means they are accelerating. But according to Maxwell's elegant classical theory of electromagnetism, this would mean that the negatively-charged electrons would radiate away some of their energy as a consequence of their acceleration. As a result, the electrons should then spiral towards, and then crash into the nucleus. This would be a disastrous outcome, as it would imply that all atoms are unstable. This made no sense.

It is important for us to take note that although some scientists like to speak of atoms, protons, neutrons and electrons as particles, the fact is they are not. They are not even solid material, even though they constitute the fundamental building blocks of everything we perceive to be solid. These basic building blocks of matter are mostly empty space. The particle representation is just a convenient means of visualizing them with our human sense of what we perceive to be reality. Atoms are actually a representation of a world of energy and information, so complex that most scientists believe it may be beyond our capacity to understand or truly visualize them.

An interesting way to visualize the actual "solidity" of an atom is to recognize that over 99.9 percent of your body mass consists solely of the nuclei of atoms, *i.e.,* protons and neutrons, each jiggling at one-third the speed of light (~100,000 meters per second or 62,000 miles per second), and each of which is as super dense as what astronomers term a neutron star. These protons and neutrons exist in a huge emptiness. If we could eliminate all of the space between the protons, neutrons and electrons in our bodies, and then pack the entire 6.6 billion-person human race together, it would distill down to the size of a sugar cube, 1 centimeter on a side, weighing an amazing 500 million metric tons. We can see that an atom with all of its electrons, neutrons and protons occupies a large amount of space. A typical atom has the same proportional size to an apple as an apple does to the size of the earth. So, solid matter is very empty and what we perceive by our sense of touch to be solid is simply the electrostatic forces of repulsion between our hands and whatever it is that we touch.

Bohr's Quantum Jump

"A physicist is just an atom's way of looking at itself."
Niels Bohr, Nobel Laureate, "Father" of Quantum Mechanics

The complexity of the true reality of an atom did not stop Danish theoretical physicist Niels Bohr from building on the ideas of Planck, Einstein and Rutherford, and from formulating the first effective model of the atom and its quantum properties. In 1913, Bohr published his quantum mechanical model of the hydrogen atom by making a revolutionary proposal inspired by Max Planck's work on blackbody radiation and Albert Einstein's work on the photoelectric effect; both of whose efforts made fundamental use of the quantum concept, *i.e.,* certain physical changes in atomic and molecular phenomena occur in abrupt, discrete steps, not in a continuous fashion. In the case of blackbody radiation and the photoelectric effect, particles of light are delivered in specific packets of energy called quanta, later renamed photons.

For the hydrogen atom, Bohr envisioned the hydrogen nucleus as a single positive proton, and an electron circling the nucleus in planetary fashion. He made two unprecedented assumptions that fly in the face of classical physics. First, he assumed that the electron in the atom existed in only stationary fixed orbits. Bohr maintained that the single electron in the hydrogen atom could be excited to higher energy states, where it could spin around the nucleus in different, higher energy orbits. *However, to get excited to one of these higher energy levels, the electron could absorb energy only in specific packets or quanta. It could not absorb energy over a continuous energy spectrum. Mathematically, this means that a continuum in energy has been replaced by discrete specific values, namely 1, 2, 3 . . . packets of energy.*

A profound consequence of Bohr's assumption is that an electron "jumps" or is "excited" from a lower energy level to a higher energy level, or conversely, the electron exists at the initial energy level and then at the final energy level, ***but never in between***. That is absolutely forbidden. This is a kind of Star Trek "Beam me up, Scotty" phenomenon, more appropriately known as a quantum jump. Schrödinger, as discussed above, already deeply disturbed by the superposition principle, was irate about what called, "Those damned quantum jumps!"

The second assumption made by Bohr was also a quantum assumption, similar to that originally made by Planck for blackbody radiation and by Einstein for the photoelectric effect when they assumed that energy was transferred in discrete packets of photons, given by the formula, $E = nh\nu$, where E is energy, n is a simple positive integer *i.e.,* 1, 2, 3, . ., h is Planck's constant and ν is the vibrational frequency of the photons. For the case of the hydrogen atom, Bohr assumed that the angular momentum of the electron spinning around the nucleus was "quantized" according to the formula: $l = mvr = nh/2\pi$, where l is the electron's angular momentum, m is its mass, v is its angular velocity as it spins about the nucleus, r is the radius of the electron orbit about the nucleus, *i.e.,* the distance of the electron from the very center of the nucleus, and n is an integer 1, 2, 3, . . .

Here Bohr borrows the formula for angular momentum from classical physics, $l = mvr$. And just as Planck did for energy generation from blackbody radiation and Einstein did for energy generation in the photoelectric effect, *he assumes that angular momentum can only be generated in integral amounts.* In making this assumption, Bohr maintained that the angular momentum of the electron was *quantized*, that is to say it could only change in discrete amounts, not in a continuous manner as would be the case for a classical system, such as a ball on a string spinning in a circle with a radius equal to r.

Bohr's assumptions worked nicely. They avoided the annihilation of the electron by crashing into the nucleus, but most importantly, his model permitted calculation of precise properties of the hydrogen atom; in particular it enabled him to calculate the experimentally observed spectral lines for the hydrogen atom.

In many respects, Bohr's model for the atom was a triumph. It demonstrated the observed stability of the atom. Once the electron was in its lowest energy state (where n = 1 in $E = nh\nu$), it had nowhere to go, and could not radiate away energy and spiral into the nucleus, as predicted by classical physics. It permitted precise calculation of the properties of the hydrogen atom, most particularly its spectral lines, as measured by a spectrometer when the atom is excited to higher energy states. When this happens, the electron falls progressively to lower energy levels until it reaches the lowest level, also called the ground-state, again where n = 1 in $E = nh\nu$ and then continues its stable revolution about the nucleus. For

each quantum jump from higher energy levels, Bohr assumed that the excess energy was radiated away with the emission of discrete quanta of photons, which are responsible for the spectral lines measured for hydrogen. His theory agreed precisely with all experimental results for hydrogen. The very sharp nature of the hydrogen spectrum was interpreted as a measure of the "discreteness" that would eventually be recognized as a fundamental characteristic signature of quantum processes. Thus, as opposed to a broad band of energy emission, which is characteristic of an energy continuum, *i.e.,* energy values smeared over a continuous range of values, quantum processes occur at precise energies and, in turn give rise to precise discrete values in their measured spectra. For his efforts Bohr won the 1922 Nobel Prize in physics.

The Matrix and Heisenberg's Uncertainty

> ***"The problems of language here are really serious. We wish to speak in some way about the structure of the atoms. But we cannot speak about atoms in ordinary language."***
>
> *Werner Heisenberg, Nobel Laureate and Founder of Quantum Mechanics*

Bohr's work was a triumph, but it had limitations and was actually the essence of what would come to be called the "Old Quantum Mechanics." In spite of its great success in calculating the spectrum for the hydrogen atom, Bohr's model could not be extended for atoms beyond hydrogen. It did not even work for helium, the next element after hydrogen in the periodic table. Also, Bohr's theory turned out to be inconsistent with Heisenberg's Uncertainty Principle, which as we will see below is a fundamental principle of nature.[1]

However, Bohr's work turned out to be a valuable staging point on the way to the development of the "New Quantum Mechanics," the fundamental basis for which was developed independently by Werner Heisenberg and Erwin Schrödinger. In 1925, while recuperating from a serious bout of hay fever, as a means to distract himself from his physical discomfort, Heisenberg developed what is now called matrix mechanics, which replaced the Old Quantum Theory. The approach he used was based on the use of matrix algebra, at the time, an obscure branch of mathematics. As a consequence of the use of this mathematical method, *he discovered that the motion of the electron was not precise at the quantum level, and in fact that electrons in an atom did not travel in sharply defined orbits as the Bohr model had assumed. Rather, the motion of the electron was smeared out about the atom.*

Although electrons spend the preponderance of their time within close proximity of the nucleus, there is a finite and calculable probability that they could be found anywhere in the universe. This all followed from a striking mathematical feature of the matrices, which Heisenberg used to represent the electron's position and its momentum (momentum = mass x velocity) in the atom. The fact is

[1]As it turns out, in modern quantum theory, it is not possible to specify exactly both the electron orbit and its angular momentum simultaneously, as Bohr did in developing his model. This is a violation of Heisenberg's Uncertainty Principle, which had yet to be discovered when Bohr developed his model.

that the matrices do not commute. This means when considering elements A and B within a given matrix that A x B does not equal B x A, as is the case in a simple arithmetic calculation (*e.g.,* 2 x 4 always equals 4 x 2). Heisenberg would later discover the profound physical implications of the mathematics, namely that it is impossible to determine both the position and the momentum or velocity of the electron with complete precision. This new model for the atom allowed Heisenberg to do everything that the Bohr model did, and much more.

It was only a year later, in March of 1926, when Heisenberg showed the game-changing implications of the fact that the matrices do not commute, namely that this implies an uncertainty in any quantum measurements. *Mathematically, any two variables that do not commute cannot be measured simultaneously and therefore the more precise that one is known, the less precise the other is known.* Heisenberg showed quantitatively that if we measure properties of an electron such as energy (E) at a given point in time (t), or its location (x) and momentum (p), then the uncertainty in the measurement of each of these variables [represented by ΔE, Δt, Δx, Δp, respectively] is related by the following equations, where h is Planck's constant.

$$\Delta E \cdot \Delta t \geq h/4\pi \qquad \Delta x \cdot \Delta p \geq h/4\pi$$

Because the quantity h/2π occurs so frequently in the mathematical expressions of quantum mechanic, sometimes these equations are written as follows:

$$\Delta E \cdot \Delta t \geq \hbar/2 \qquad \Delta x \cdot \Delta p \geq \hbar/2$$

where $\hbar = h/2\pi$, and is called "h-bar."

These equations mean, for example, that the uncertainty you measure in the position of an electron (Δx) times the uncertainty you measure in its momentum (Δp) will always be equal to or greater than the value of h/4π or ħ/2. *This result is neither a statement about the inaccuracy of your measurement instruments, nor a reflection of the quality of your experimental methods. The uncertainty in these measurements arises strictly from the mathematical wave properties inherent in the quantum mechanical description of nature, and it is elegantly expressed*

via the mathematics of matrix mechanics. Even with perfect instruments and technique, the uncertainty is inherent in the nature of all material things, since as we will see from Louis de Broglie's work (below), all material things have wave properties associated with them.

A physical picture of the Uncertainty Principle can perhaps be more clearly drawn from the following explanation. Suppose you want to measure the position of an electron spinning about the nucleus. If you use modern instrumentation to measure its location within a small distance in its orbit, let's say within a distance equal to Δx, then the wavelength of the light required to "see" the electron must be at least as small as Δx. This simply means that for the electron to be "seen," a photon of light must interact with the electron, and thus must be comparable in "size"; otherwise if the wavelength of the photon were larger than the electron, it would just pass right by it, and the electron would appear "transparent" to view.

However, the photon has a certain momentum (p), which as we will see below was determined by de Broglie to be $p = h/\lambda$. Here, h is Planck's constant and λ is the wavelength of the light or photon. When the photon interacts or collides with the electron in order to "see" it, some of the photon's momentum is transferred to the electron, which leads to a small change in the position of the electron—picture a billiard ball smashing into second billiard ball. Thus, the very act of "looking" at the electron leads to an alteration in its momentum, and therefore a change in its location. As a consequence, the accuracy of "seeing" or locating the electron always has an uncertainty associated with the measuring process.

A more amusing statement of the Uncertainty Principle is that *you can know where a particle such as an electron is precisely located, but not know what it is doing; or you can know what it is precisely doing, but not know where it is.* Heisenberg won the Nobel Prize in physics in 1932 for his work on matrix mechanics.

De Broglie and Schrödinger Make Waves

> ***"I do not like [quantum mechanics], and I am sorry I ever had anything to do with it".***
>
> *Erwin Schrödinger, Nobel laureate and Creator of the Schrödinger Wave Equation, lamenting the metaphysical (probabilistic) nature of quantum mechanics*

Although Heisenberg's matrix mechanics was an incredible advance, the theory was not readily accepted by other physicists as it was based on matrix algebra, a field of mathematics unfamiliar to most theorists at the time. Instead, physicists preferred to deal with differential equations. After all, differential equations and the calculus for solving them are arguably the most powerful tools ever developed for making quantitative sense of the material world.

A not-so-young (38 years old), Austrian physicist by the name of Erwin Schrödinger came to their rescue. Throughout most of his entire life, Schrödinger was a "ladies' man," although it is a matter of colorful debate by his biographers as to how many affairs he had. However, during one of them, while staying with a lovely young lady at a ski lodge in Arosa, Switzerland, he had a "eureka moment" which led to the development of what today is the more accepted approach to quantum mechanics. It is a wave theory and is completely based on differential equations.

Schrödinger decided to follow up on the then recent bold development by a French aristocrat and physicist, Prince Louis de Broglie, who had shown that all matter—electrons, marbles and baseballs alike—possesses both particle-like and wave-like properties. However, the quantum implications of wavelength only become important for small particles such as electrons, which have long enough wavelengths to be measured.

Thus, a pitched baseball has such a short wavelength that in our perception of reality, it really doesn't matter. You can see this clearly from the deceptively simple formula derived by de Broglie, $\lambda = h/p = h/mv$ [*i.e.,* the wavelength (λ) of an object equals Planck's constant divided by its momentum (p), which is its mass (m) times its velocity (v)]. For a 0.14 kilogram baseball thrown by a pitcher at 40 meters/second, the wavelength calculates to 1.2×10^{-34} meters—very, very small compared to the size of a baseball and for all practical purposes, immeasurable.

However, if it were an electron, which has a mass of 9×10^{-31} kilograms, traveling at the same velocity, the wavelength calculates to 1.8×10^{-5} meters, *i.e.,* 18 microns, a wavelength that is easily measured, and therefore a relevant value.

De Broglie presented this work in his doctoral thesis in 1924 at the University of Paris. The work was so unbelievable that his advisor, a famous French theorist named Paul Langevin, sent de Broglie's thesis to Einstein for review, who in turn endorsed the genius of de Broglie's findings. A short time latter in 1927, Clinton J. Davisson at Bell Labs in the U.S. fired slow-moving electrons at a small single crystal of nickel metal. The regularly aligned nickel atoms provided an atomic-scale diffraction grating or "slit" just as in the Thomas Young larger paper-slit experiments with sunlight, and produced the telltale interference pattern on a photographic plate, demonstrating that electrons also behave as waves. A few months later, George Thomson in England carried out a similar experiment using gold foil and obtained the same results as Davisson, in this instance, the regular array of gold atoms acting as a diffraction grating. It was now definitively proved—*electrons not only behaved as particles, but also as waves, what became known as wave-particle duality.*

De Broglie won the Nobel Prize in physics in 1929, just five years after completing his doctoral degree, and Davisson and Thomson shared the Nobel Prize in physics in 1937 for their work, which showed that de Broglie's theory was correct. An interesting and ironic back-story is that George Thomson, who proved that electrons behave as waves, was the son of J. J. Thomson, who also won the Nobel Prize in physics 31 years earlier in 1906 for discovering the electron and showing that it behaved as a particle!

All of de Broglie's work was based on free-moving particles, those with no forces on them. To have a complete theory, it was important to take into account any forces acting on the particle, which of course, is the situation in the real world. This is exactly what Erwin Schrödinger succeeded in doing, starting with a simple differential equation for a wave and then taking into account the effects of forces on the particle and the implications of kinetic and potential energy fields in which the electron existed.

The way that Schrödinger went about developing a means to calculate the properties of quantum objects was to draw on an analogy between what are known as geometric and wave optics. During the 18th century, when many scientists believed that light was wave-like in nature—Newton was an exception—they did not worry about calculating optical phenomena starting with a partial differential wave equation. As the wavelength of visible light is quite small compared to the large dimensions defining many physical problems, *e.g.,* when passing visible light through various lenses or for reflections from mirrors (so-called geometric optics), it so happens that a whole set of simpler procedures exist to calculate theoretical results. It was unnecessary to start from first principles, using a more mathematically challenging wave equation.

Schrödinger recognized that this approach was a simplification wherein the methods used for geometric optics were in reality an approximation of the more thorough wave equation calculations. Therefore, he reasoned that if he was to instead pursue a more comprehensive and precise analysis, he might be able to discover a general equation for the dynamics of a particle under any conditions. He was successful. The equation he discovered is a complex second-order differential equation in space and time, and is one of the most fundamental equations of modern physics. It bears his name—The Schrödinger Wave Equation. He called his approach ***wave mechanics*** to distinguish it from the *matrix mechanics* of his professional arch-rival, Werner Heisenberg.

* * *

The transition from the "Old Quantum Mechanics" created by Planck, Einstein, de Broglie, Bohr and others, to the "New Quantum Mechanics" as a result primarily of the work of Heisenberg and Schrödinger, was an amazing advance in the field of physics. This era is often referred to as the Golden Age of Physics because of the incredible productivity during this period, resulting in the discovery and development of the special and general theories of relativity and quantum mechanics. This Golden Age began with Planck's work in 1900 and ended with the explosion of the first atomic bomb at Trinity Site, New Mexico on July 16, 1945, followed by the atomic bombing of Hiroshima 21 days later on August 6 and Nagasaki on August 9.

Further developments followed during this period by other great physicists and mathematicians, such as P. A. M. Dirac, Max Born and John von Neumann.

Dirac derived Planck's empirical formula for blackbody radiation directly from first principles and created a much clearer mathematical structure for quantum mechanics, so clear that it showed the equivalence of Heisenberg's *matrix mechanics* and Schrödinger's *wave mechanics*. Dirac also combined quantum mechanics with Einstein's theory of relativity, a necessity for calculations dealing with subatomic particles. In doing so, he predicted the existence of the positron, the positively-charged anti-particle, *i.e.*, antimatter for the negatively-charged electron. The positron was discovered a few years later. Dirac received the Nobel Prize in physics in 1933, just 7 years after earning his doctoral degree.

Max Born, much to the dismay of many reputable scientists such as Einstein and Schrödinger, put quantum mechanics on a definitive statistical basis. He showed clearly that if you solve Schrödinger's wave equation for a certain event or system, the probability of your seeing that event occur is exactly equal to the square of the wave function, or modulus as it is called in mathematics. Einstein was so disturbed by this result that he told Born, "I don't believe that God would play dice with the universe," to which Niels Bohr retorted, "Einstein, stop telling God what to do!" Several decades later, Stephen Hawking asserted that "Not only does God play dice, but he throws the dice where you cannot find them!" As with Einstein, and as mentioned previously, Schrödinger was so distressed by the probabilistic nature of quantum mechanics that he often said that had he known about it in the first place, he would never have created the Schrödinger Wave Equation. Born's research, which showed categorically that quantum mechanics can only have a probabilistic interpretation, caused many physicists deep stress because of the profound, some would say metaphysical, implications that follow such interpretation. This is perhaps the reason that he had to wait until 1954 to receive his Nobel Prize.

Why were these and numerous other scientists so disturbed by the implications of quantum probabilities? Because they fly in the face of the scientific method and put physics face to face with metaphysics. And that makes scientists very uncomfortable, primarily because they do not have the mathematical machinery and scientific tools to deal with metaphysical phenomena. Furthermore, hundreds of years of separation of physics and philosophy led to a disdain for mixing these two fields of endeavor. This state of affairs has sometimes been called the Quantum Enigma.

Quantum Enigma—"Wonderful Copenhagen"

"Einstein, stop telling God what to do!"
Niels Bohr, Nobel Laureate and one of the "Fathers" of Quantum Mechanics

Niels Bohr, one of the founding fathers of quantum mechanics and a shrewd statesman for the physics community, knew immediately that something had to be done to calm the concerns of scientists working in this field. He and his colleagues in Denmark developed what has been called the Copenhagen Interpretation of quantum mechanics, and to this day it is the mantle which most physicists hold high so as not to be faced with the discomforts of dealing with metaphysics. In simple terms, it basically says:

> Look, we know that quantum mechanics works; it has never made a wrong prediction or calculation. So, don't worry about the quantum enigma; simply apply the theory for calculations of small systems, such as atoms, electrons, photons and the like, where we can see that there is an observer-created world; and apply Newton's mechanics to large objects like rockets and planets, where the same situation may exist, but we can't do the experiment to prove it. True, Newtonian mechanics is an approximation of quantum mechanics, but still, it works well for large objects. So what's the big deal; don't worry, calculate and be happy!

As Bruce Rosenblum and Fred Kutter note in their fascinating 2006 book, *Quantum Enigma*, "Classical physics explains the world quite well; it's just the details it can't handle. Quantum mechanics handles the details perfectly; it's just the world it can't handle." Most physicists want to avoid dealing with consciousness; the Copenhagen Interpretation allows them to do so.

Bohr admits in his formulation of the Copenhagen Interpretation of quantum mechanics that an observation produces the property or system observed. Here, Bohr defines an observation as that which occurs whenever a microscopic, atomic-scale object interacts with a macroscopic, large-scale object, *e.g.*, when a photographic film is hit by a photon or electron and records where the photon or electron has landed. Bohr says the film "observed" the electron or photon. He then goes on to say that people never deal directly with objects in the microscopic

or quantum realm, so we don't have to worry about their physical reality or lack thereof. Actually, the human eye can detect a single photon; it's just that our brain is not wired to process such a weak signal.

The Copenhagen Interpretation is based on three fundamental technical principles:

1. **Probability**—The square of the wave function in a given region of space-time is the probability that the object will be found in that given region. *It is important to note that this probability is not where the object is located, but where you will find it. What this means is that the object was not completely there until you observed it.* If we consider the presence of a single atom in one of two boxes, quantum mechanics tells us that there is no atom in addition to its wave function. Each box contains the atom's wave function, and therefore, although we appear to be unable to fathom the fact, the atom itself is actually in ***both*** boxes until we observe the atom, at which time the wave function collapses and the atom is found in that single box. Indeed, the wave function is the only way to communicate information in quantum mechanics. In all actuality, the wave function is the entire story. Some physicists say that there is no atom in addition to the wave function, and actually the wave function is synonymous with the atom. The wave function does not carry specific information as to how a particular entity will behave or a specific event will occur. Rather, it is an expression of potential or statistical probability. This is in stark contrast to classical physics where answers are always exact and specific and the future of a given system is precisely predictable.

2. **Uncertainty**—As discussed above, according to Heisenberg's Uncertainty Principle, if we consider the position and momentum (mass x velocity) of a small particle such as an atom, the more precisely we know its velocity or momentum, the less precisely we know its position. *The fact is that any observation disturbs things enough to prevent disproval of quantum mechanic's assertion that observation creates the property observed.*

3. **Complementarity**—The particle-like and wave-like behaviors of a microscopic object are "complementary." *A complete description of the object*

> *requires that we make use of both behaviors, but never at the same time. This is a statement of the complementarity of Newtonian or classical mechanics and quantum mechanics.* The macro world obeys Newtonian mechanics and the micro or quantum world obeys quantum mechanics. If we do a wave-like experiment, we will always get a wave-like answer; if we do a particle-like experiment, we will always get a particle-like answer.

The Copenhagen Interpretation has enabled most theoretical physicists to go about their work without the worries of confronting metaphysics and consciousness—they can sleep at night.

Entanglement—I Feel Your Presence

> ***". . . thou canst not stir a flower without troubling a star."***
> *Francis Thompson, English Poet*

Entanglement is another metaphysical-like aspect of quantum mechanics. Einstein called it "spooky action at a distance." In simple terms, entanglement maintains that observation of one object can instantaneously influence the behavior of another object, even at very great distances, and even when there appears to be no physical force existing between the two objects. *Entanglement is a prime example of the non-local nature of quantum mechanics and is an integral part of the concept of "connectedness" in the universe.* The metaphysicist would say, "We are all connected in some manner," and in doing so refer to Individual Consciousness and Universal Consciousness, both being integrally one.

The three physical aspects of "non-locality" and therefore entanglement are: ***First****, interaction is instantaneous, i.e., faster than the speed of light.* ***Second****, because there is no field or medium necessary for this contact to be made or maintained, nothing can block it from occurring. And* ***third****, distance does not weaken the contact or interaction.* It could just as well occur over the distance of many galaxies as over several meters, both with the same intensity of interaction, and the same time required to occur.

Entanglement experiments have usually been carried out with electrons, photons or small molecules. Recently, J. D. Jost *et al.* reported on an amazing experiment in *Nature* [**459***,* 683-685 (2009)], wherein they have been able to entangle two mechanical oscillators, represented by two separated ion pairs. Changing the vibration of one instantly changes the vibration of the other.

Contemplating entanglement, Einstein proclaimed that, "The Lord God is subtle, but malicious He is not." Although, years later, after much work and thought on entanglement and non-locality, he changed his tune, "I have second thoughts, maybe God is malicious."

A Bell Tolls for Dr. Bell

"Nothing real can be threatened. Nothing unreal exists."
Jesus Christ (through Helen Schucman), "A Course in Miracles"

Modern cosmological theory maintains that at the birth of the universe all matter and energy were contained in a "singularity," a small speck—billions, perhaps "zillions" of times smaller than an atom—in a huge emptiness of absolute nothingness. This singularity exploded into what we call the Big Bang, and continues to expand. Therefore, we might consider that the constituents of all things in the universe were at one time all one, and intimately connected, and therefore continue to be so. Einstein called this "quantum weirdness."

He and others conjectured that perhaps there are "hidden variables" in quantum mechanics, factors that if known, could explain all of this "quantum weirdness." However, Irish physicist John Stewart Bell, while on a restful sabbatical, proved that this could never be the case. His work has been hailed by some as "the most profound discovery in science in the last half of the 20th century." Bell's work answered once and for all in the laboratory what was previously considered a purely philosophical statement—*There indeed is universal connectedness! Einstein's fear of "spooky action at a distance" is well-founded in that any objects that have ever interacted will continue to instantaneously influence each other, i.e., in a timeframe faster than the speed of light—so-called superluminal speed!*

Bell's Theorem consists of two assumptions. The *Reality Assumption* supposes that objects in our world have physical properties that are ***not*** created by observation. The *Separability Assumption* supposes that two objects can be separated from each other such that what happens to one does ***not*** influence the other.

Using an elegant relatively simple and straightforward derivation, Bell proved that certain observable physical quantities had to be larger than other well-defined observable quantities if these two assumptions were correct. This is an experimentally testable prediction of Bell's Theorem, which became known as Bell's Inequality. When the experiments were finally done, first by Alain Aspect and co-workers in France, and then by others, *Bell's Inequality was shown to be violated, which means that the Reality and Separability Assumptions are both*

incorrect for our universe. Therefore, we create our reality by observation and all things are connected such that instantaneous entanglement—connectivity—is prevalent throughout our universe.

Experiments have been done over distances of tens of kilometers with photons, molecules and other small molecular systems, and always verify the veracity of entanglement. The current record distance is 144 kilometers, from La Palma to Tenerife in the Canary Islands. Measuring one particle of an entangled pair immediately affects its counterpart, no matter how far apart they are, and it does so instantaneously, *i.e.,* faster than the speed of light. One particle could be at the other side of the galaxy, and the communication would still be instantaneous. These effects apply not just to microscopic systems, but to large systems as well. *In principle, any two objects that have ever interacted are forever entangled—the behavior of one instantaneously influences the other. Indeed, our universe has a mysterious connectedness that goes beyond known physical forces.* Quantum computers of the future are expected to take advantage of the use of entanglement. Perhaps quantum entanglement has an even deeper meaning than we have yet to discover.

Teleportation—Beam Me Up Scotty!

"We are not only observers. We are participators. In some strange sense, this is a participatory universe."
John Archibald Wheeler, Quantum Cosmologist

Another "spooky" aspect of entanglement is teleportation, transmitting matter through space to another location. This is no longer an area of science fiction. Anton Zeilinger and his team at the University of Innsbruck in Austria successfully accomplished "quantum teleportation," based on the principle of non-locality which is responsible for entanglement. Essential information contained within one of two entangled photons was transmitted instantaneously, over a distance that could just as well have been millions of light years, materializing in the form of a third photon identical to the first. The initial photon vanished in the teleportation experiment.

IBM scientists are among those most involved with this phenomenon, and there is talk of developing incredibly fast networks based on quantum computers that will utilize photon teleportation. The strength of non-locality is the basis for this experimental technology. The fact that we are baffled by this mystery does not lessen its value. It is good science, science that can enable a bright future to unfold despite the challenging barriers blocking our vision at present. In fact, the success of quantum computing may rely on teleportation and other "metaphysical" quantum phenomena. There are implications for Einstein's theory of relativity that have yet to be "untangled," since it has been clearly demonstrated that information can indeed travel faster than the speed of light. Perhaps, bringing clarity to this unresolved mystery will not only refine the theory of relativity, but also shed light on the workings of our universe.

Although quite matter-of-fact about both of Bell's assumptions, Bohr's Copenhagen Interpretation of quantum mechanics agrees that the Separability Assumption and the Reality Assumption are violated, and therefore, it follows from Bell's Inequality that there are no hidden variables in quantum mechanics. However, the Copenhagen Interpretation still maintains that one should just "calculate and not worry about metaphysical implications." Some physicists, now compelled to accept the proof of entanglement, but uncomfortable with its implications, have stated but not proved the position that "Perhaps entanglement

travels faster than the speed of light, but surely awareness can not!" What they are saying is, "Perhaps a signal from one electron or photon to another could travel instantaneously across galaxies, but surely awareness cannot!" I believe that continued efforts on the development of quantum computing will resolve this issue, and perhaps open our eyes to a different way of looking at reality, our existence and the universe.

* * *

One final note. All of the great physicists, who have lived since the birth of quantum mechanics—from Planck to Einstein to Bohr to Heisenberg to Dirac to Feynman to Hawking—all maintain two profound conclusions: (1) quantum mechanics is arguably the only scientific theory that has never made an incorrect prediction; and (2) it is impossible to do quantum mechanics without encountering consciousness. Could this be telling us something?

Part III
What Does This Mean For Your Reality?

"The truth in you remains as radiant as a star, as pure as light, as innocent as love itself. And you are worthy that your will be done!"

Jesus Christ (through Helen Schucman), "A Course in Miracles"

Quantum Reality

"It is possible in quantum mechanics to sneak quickly across a region which is illegal, energetically."

Richard Feynman, Nobel laureate for Quantum Electrodynamics

In the nearly 100 years since its discovery, quantum mechanics has never made an incorrect prediction. It may well be the most successful scientific theory ever developed. So, when we consider what it has to say about consciousness and our universe, we might ask, "How can we distill this down to something that summarizes clearly what it truly means for anyone who cares to use the power it offers for personal evolution, or for that matter, to help facilitate the evolution of the universe?" That said, we must recognize that certain aspects of what quantum mechanics has to say were actually discovered intuitively in a spiritual context more than 2000 years ago, by the Sages and Wisdom of the Ages.

The power of modern quantum theory is that it provides a mathematical and scientific framework for why the universe and our conscious self, *i.e.,* our soul, are the way they are. And in doing so, even a layman's summary of quantum mechanics provides specific direction on how we can improve upon the Wisdom of the Ages in the evolutionary process. For reasons that will be apparent, we must start at the very beginning if we are to understand the fundamental truth and essence of what this all means for our reality and our ability to improve on it.

Just before that very first instant of time, at the beginning of it all, everything in this universe was one—a single speck, a singularity, billions if not "zillions" of times smaller than an electron. And yet, as amazing or miraculous as it may seem, that single speck contained all of the energy and mass that would ever be. In a very real sense, everything in the universe was "connected" from the start at the energetic level within that singularity. There could be no matter during these first moments in time, as "we" were under the prevailing conditions of unimaginable compression. But from all that has been discussed in this essay, it is hopefully clear that it is energy and not mass that truly matters when it comes to consciousness and spirit. Although, it is true that Einstein might comment—and appropriately so—that energy and mass are directly interchangeable, related simply by the speed of light squared, $E = mc^2$.

As the first moment in cosmic creation got underway some 13.7 billion years ago, everything, all of the energy and the precursors to all of the mass that would eventually become "us" and everything around us rapidly exploded with spherical symmetry in all directions. Every bit of that incalculable locked-up energy began to expand into the infinite void and ultimately a transition to what we now call the "dark energy" and "dark matter" of the universe—energy and matter that we know from their effects on universal gravity are "out there," but have yet to be observed with our five senses. This transition is well described by Einstein's famous equation, $E = mc^2$, albeit modified to take into account the effects of relativity, when particles are moving at close to the speed of light.[1]

A small amount of that energy, cosmologists calculate about 5%, ultimately coalesced into the entire mass that we now observe, more precisely that we create as our universe, by our observation. *So, on an energetic and eventually on a material basis, we have all been connected from the very start. All peoples, all things, have at one time been intimately coalesced at the energetic level, and with time, at the mass or material level, as well. Everything—you, me, Mt. Everest, the fish in the sea—we are all descendents of the same primordial energetic stuff that 13.7 billion years ago was intimately united in a singularity floating in a great field of "nothingness."*

This is especially clear when we consider cosmic creation within the star systems of the galaxies of our universe. Of the 91 naturally-occurring elements[2] that make up our planet, nearly all of which were synthesized within these stars, several are the atomic building blocks that have formed the molecular fabric of humanity since its genesis. We are without question or exception, all children of the stars.

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[1] $E = [(pc)^2 + (mc^2)^2]^{1/2}$, where E = energy, p = momentum (*i.e.,* mass x velocity), m = mass, and c = speed of light. This simplifies to $E = mc^2$ for particles moving at low velocities compared to the speed of light.

[2] For some reason unknown to me, many chemistry texts state that there are 92 naturally-occurring elements on earth, but this is not correct. Technetium, which is element number 43, is a radioactive isotope, used primarily in medicinal chemistry, and does not occur naturally on earth, but is prepared in a nuclear reactor by the fission of uranium or plutonium isotopes.

Therefore, when we invoke the power of quantum mechanics, all of the necessary conditions exist for entanglement to occur throughout the universe. Since we are made up of atoms, and atoms are quantum entities, subject to the rules of quantum mechanics and entanglement, then we, and in fact all matter throughout the universe are also subject to those same rules. *As we are all connected, we can in principle and in practice, influence people, things and events at large distances, and this influence, under appropriate conditions, begins its effects in an instant, i.e., immensely faster than the speed of light.*

The question then arises, "Are certain people, things and events easier to influence than others?" I think so. For example, I believe that I have much greater instantaneous distance contact and influence on my wife and three children than say, on Angela Merkel or Barack Obama, or anyone else whom I have never met and interacted with for any significant period of time. However, this does not mean that I cannot influence Merkel or Obama; it just requires more effort. Why is this?

It all comes down to what level of effort is required to collapse the quantum wave function that describes a specific event we wish to influence. The event of interest may have a large, perhaps in some cases, an infinite number of possibilities. From quantum mechanics, we say that the overall wave equation describing this event is a superposition of an infinite number of wave equations, each representing one of these possibilities. Quantum mechanics tells us quite clearly that the probability of our seeing a specific event occur may be mathematically calculated by squaring the wave equation for that specific event. I believe that for people with whom we have had intimate contact, we develop the ability for our personal soul to overlap its influence and interact much more intensively with their personal soul, and therefore through the mechanism of the universal soul or consciousness, we can more readily reach out to them wherever they may be.

In quantum mechanics, we would say that the wave equation for the system of interest takes on a number of degenerate states. The greater the intimacy, the greater is the degeneracy. In plain English, this means that many of the possible outcomes are the same, *i.e.,* they "degenerate" into a single probability, and therefore, there is a substantial increase in the probability of bringing about

the desired outcome with much less effort. However, we can in principle and in practice influence complete strangers, albeit with greater effort. With some of the techniques described in Part I, it is possible to influence the most distant event or individual, and collapse the superposition of a huge number of wave equations to the one that describes the event you want to manifest. Without any doubt, history has demonstrated repeatedly that you can do this!

A fundamental requirement in this process is quiet connectivity with the universal consciousness via meditation. As discussed previously, through meditation, it is relatively easy to access your personal soul, and since your personal soul is connected to the universal soul or consciousness of the universe, it is therefore possible to communicate with the universal soul, and thus with the personal soul of an individual of interest, since that individual's soul is also connected to the universal soul.

Quantum mechanics tells us that what exists "out there" in the realm of "potentia" is often an infinite number of possibilities. It is our observation of the universe that creates a specific possibility. Using our personal and universal consciousness is a powerful mechanism to create what you want in this world provided it does not violate any of the natural laws of our universe. For example, it would not be a good idea to jump out of a skyscraper in an attempt to manifest your intention to fly! On the other hand it will take much work for many of us, for example, to influence key individuals in the Middle East to bring about a peace there. But, with sufficient effort, I believe that this is a real possibility, as is influencing the relevant personalities and events necessary to address poverty, climate change, energy security, and rampant disease in the undeveloped world. In these instances, it may require consistent effort over a long period of time on the part of a number of spiritually-inclined individuals. The numerous anecdotal reports of the immense and successful power of prayer likely involve this same mechanism.

Quantum mechanics has also proven that your observation not only creates your present reality, but also creates backwards in time that history which is appropriate for your reality. After all, the concept of time is a convenience dreamed up by humanity. It is not a fundamental parameter of the universe. Astrophysicist

Bob Berman argues that "Time for example, now appears to be a mere ordering process created by the mind's circuitry. What we perceive as time is the specific sensible way our brains arrange complex electrical inputs. The widespread notion of a self-existing temporal grid is almost certainly illusory." When we speak of space-time, even space is arguably a non-reality of the universe, but both time and space are concepts that allow us to do the math as we have developed it.

> *"According to general relativity, the concept of space detached from any physical content does not exist."*
> *Albert Einstein*

> *"Time, space, and causation are like the glass through which the Absolute is seen…*
> *In the Absolute there is neither time, space, nor causation."*
> *Swami Vivekananda (1863-1902), Chief disciple of Ramakrishna; Introduced Vedanta and Yoga to the West*

The question then is, "Can we create a specific future?" I think we can. The creation of desirable futures has been described for thousands of years by the Wisdom of the Ages. This I think, is the basis for the manifestation of desirable futures through the practice of meditation: *close your eyes—focus on love within your heart—let go of your ego—quiet yourself to the presence of your personal soul—envision the future you want—be grateful for what you already have—let the universe handle the details—wait patiently for the results.* Many, many people over the ages have shown that this method works. Quantum mechanics simply explains it, and provides a basis for improving on our manifestation techniques.

As for teleportation, although throughout history there have reportedly been holy men and women who were said to walk through walls, *e.g.,* Jesus Christ, I am not sure we will soon learn how to "Beam me up Scotty," as Captain Kirk does in the Star Trek science fiction series. But, *it should be possible to experience sensory teleportation to remote places through your personal soul via its connection with the universal soul, and thereby experience distant events and places through the senses of your soul.* This requires translation and transcription from the multiple

levels of consciousness of the soul to the five senses of the body. This is possible through meditation. Perfecting this practice should allow you to "go" anywhere on earth, and in fact, anywhere in the universe.

However, I believe that to access this powerful tool requires purity of heart and a positive motive and intent because true access to the soul-body connection is not possible in a maligned state of distress, hatred or revenge. It requires the intoxication of love and positive intent to improve the universe. This assures that this tool can never be used for the purpose of evil or harm. That is likely the reason that the CIA and other clandestine governmental agencies failed miserably after spending millions of dollars on "remote viewing," another term for this form of conscious sensory teleportation. Their intent was to capture information from the "enemy." *Just as it is forbidden to violate any of the natural laws of the universe, the personal and universal soul connection cannot be used for negative purposes, to violate the spiritual laws of the universe.*

A Final Thought—What About God?

"Before Abraham was, I am."
Jesus Christ

How does God enter into this discussion? Most religions embrace the concept of love in the fabric of their essence—usually love of self, love of others, and love of God. In this respect, the teachings of organized religion overlap with some of the concepts discussed in this essay. However, there are some very important differences.

For example, there is without question a strong imprint of the male gender in most religions. As a consequence, they tend to speak most often through the face of "man," and are directed at a common male denominator among the faithful. All great prophets throughout history were men—Moses, Abraham, Jesus, Rumi, Buddha. They and their followers were the scribes of essentially all religious dogma. For example, in Christianity, the virgin birth of Jesus, Mary's bodily assumption into heaven, and the transubstantiation of bread and wine into the actual body and blood of Christ were the written word of the authors of the gospels—all male protagonists.

They depict God as an all-powerful, all-knowing, all-loving, all-forgiving white male, somewhere "up there" in heaven; and Satan—the angel Lucifer gone bad—as man's potential nemesis banished to Hell, somewhere "down below." Much of this, in my opinion, is interesting mythology, but just that.

> *"The 'devil' is a frightening concept because he seems to be extremely powerful and active. He is perceived as a force in combat with God, battling Him for possession of His creations. The devil deceives by lies, and builds kingdoms in which everything is in direct opposition to God. Yet he attracts men rather than repels them, and they are willing to 'sell' him their souls in return for gifts of no real worth. This makes absolutely no sense."*
>
> *Jesus Christ (through Helen Schucman),*
> *"A Course in Miracles"*

Such dogma was often created or significantly modified in substance by men who appeared on the scene long after the genesis of the religion in question. And it was and still is usually proclaimed by religious male leaders that should this dogma not be embraced enthusiastically in its entirety, your very "salvation" is at risk.

Consider Catholicism. What fundamental, spiritual, or even practical difference would it have made if Mary were to have relinquished her commitment to life-long virginity, and married a holy man named Joseph, and subsequently gave birth to Jesus Christ? What difference would it have made if Jesus truly lived the life of a holy yet normal man, ultimately falling in love with and marrying Mary Magdalene and having children, as depicted in the gospels according to Phillip? What difference would it make if the transubstantiation of bread and wine into the actual body and blood of Christ is just symbolic? And what difference would it have made if Mary's body was not assumed into heaven, but was buried in the earth, as was that of her only begotten son?

In my opinion, it would not make any difference. It would appear that these articles of dogma were developed for other reasons, most probably for motives of power and control. This would seem to be in fundamental conflict with the way of Christ, Buddha, Rumi, or of any of the other spiritualists throughout the ages. These dogmatic teachings were created out of a deep concern for losing control, which fostered a need to incite fear within the hearts of the faithful.

Unfortunately, the history of religion, as spiritual as it may be in some contexts, is also one shadowed by murder, rape, ethnic cleansing, war, and retribution—and, sadly, this continues to this very day. The implications and impact of the Spanish Inquisition and the Holy Crusades are but two examples of many throughout history. Today's global Holy War between Christian and Muslim nations, mingled with deadly terrorism, is no less tragic, and has even greater potential for broad-based devastation. This kind of behavior was never intended by the holy men from whom religions sprang forth. Christ, Buddha, Rumi, Abraham, and many other spiritualists were not threatening; they were the epitome of forgiveness and understanding, and they offered love as light for the journey—not fear "to keep you out of Satan's grasp." The reason is clear, love is healing, but it is also

all-empowering, while fear constricts and controls. And control was a key objective of the early leaders—not the founders—of organized religions. One might even wonder if these holy men intended their teachings to be the basis for an organized religion.

Let me be clear. It is not my objective to disparage organized religion, as it has met the needs of billions of people, and it continues to do so. Most religions are populated by well-intentioned people. If there is any critique due, it is not of any given religion per se, and certainly not of its spiritual founders, but is directed at a minority of powerful men who built, managed, and controlled these religions—and continue to do so.

There are numerous, incredible human beings, some might say saints, that have arisen within the ranks of organized religion. Mother Theresa, Francis of Assisi, Ghandi, and Thomas Aquinas are but a few examples. Somehow these spiritual beings found both their personal and collective souls, and thereby discovered a means to look beyond the atrocities of those few men who controlled their religion, and were obsessed with their self-generated dogma. These saintly people saw only faith, hope and the omnipotence of love. They heard clearly the message of their religious founder. That message was always the same, regardless from which religion it emanated—"Love thyself as deeply as you know how, and love God and thy neighbor as you love thyself." This is a very powerful doctrine as it forestalls even a hint of war, discontent, malice and retribution. This, of course, flies in the face of control of people, nations, wealth and, in fact, of all material things.

So, in view of this commentary, how do I see the presence of God in our universe? First of all, in contrast to the current thinking of modern cosmology, I see the creation of our universe as an event that likely occurs over and over again, each universe lasting many billions of years. Time is irrelevant in the world of spirit. I believe that cosmologists will eventually discover that the expansion of our universe is not accelerating, as is currently believed, but it is slowing down, and will ultimately contract in a process that has been referred to by some physicists as the "Big Crunch." All energy and matter will subsequently coalesce back down to a singularity, similar to that from which it started. Every molecule, atom,

atomic and subatomic particle, every form of energy will once again become "one" as it was in our last "beginning." And eventually, that singularity once again will explode and expand into another universe, and this process will likely occur for all eternity, evolving a new universe and further evolving universal consciousness with each Big Bang to a higher plane of existence.

My thinking on the universe is not based entirely on arguments from physics and cosmology, but also on tenants of metaphysics. Thus, from astrophysics we know that there is essentially no known body in the universe, including the earth, our solar system and much more, that will not someday be destroyed in a transition from mass to energy. For example, we are relatively confident that a few billion years from now, changes in nuclear reactions within our sun will slowly force it to expand into a "red giant" star, thereby pushing the earth farther out into space—but not far enough. Our home in this universe will eventually be enveloped by the sun's outer atmosphere, gradually forcing the earth to plunge into the fiery stellar furnace of the "red giant." But more to the point, I invoke the metaphysical Wisdom of the Ages through the words of Buddha, "Whatever arises will also subside." Just as the universe arose, it will subside.

Some physicists believe that this process may be occurring at this very moment in parallel and in different universes, each with their own unique laws of nature. This is the so-called, "Many Worlds" interpretation of quantum mechanics, formulated by Hugh Everett in his 1957 Ph.D. thesis, while working with John Archibald Wheeler at Princeton University. His theory was later refined by Bryce DeWitt, a colleague of Wheeler's. Basically, what Everett and DeWitt say is that the wave function does not collapse down to one probability by our observation, but that all possibilities are realized, each in a different copy of our universe. As DeWitt points out, "Every quantum transition taking place on every star, in every galaxy, in every remote corner of the universe is splitting our local world in myriads of copies of itself." In this formulation, there is no collapse of the wave function, and the universe is replaced by a "multiverse" of parallel universes—some physicists believe an infinite number, each with its own wave function. This theory is not espoused by many physicists, although there are a few giants among the believers, David Deutsch of Oxford and Stephen Hawking of Cambridge, to name two.

So how does God fit within this picture? First, I think we must acknowledge that God is impossible to define. Any attempt to do so would limit Him to our human beliefs and conceptions about Him. I use the male gender by accepted convention; however without doubt neither "Him" nor "Her" is appropriate. If any gender is to be called upon, it surely must be "It," or perhaps some creative intimate fusion of "Him," "Her" and "It!" Organized religions do not espouse this tenet; they expand on and interpret their founders' words in a manner that creates an easily understandable picture that will resonate with their congregation. As for me, I believe we must seek the concept of God at the interface of quantum physics and the wisdom traditions of Eastern thought.

In Part II of this essay, we learn that quantum physics asserts that everything we experience in what we perceive to be the material world is actually created in an invisible realm beyond space and time, a realm that Heisenberg's matrix mechanics and Born's probability interpretation of Schrödinger's wave equation tell us is a "discontinuity." ***This discontinuity is consciousness itself*** and in simple terms can be described as an "on-off" vibration. In the "on" state, there exist energy and information, and in the "off" state, infinite possibilities. This invisible source of all that currently exists, all that has ever existed, and all that ever will exist is not an empty void. It is the womb of creation for all things—tangible and intangible—be it a galaxy, a gorilla, a person or a thought. Heisenberg called it a "place of infinite potential," and in truth it is actually not a place. Each of these infinite possibilities can be accurately described by the Schrödinger wave equation. And as Born so eloquently proved, each possibility is accessible by our observation or intention, leading to collapse of the wave equation to one specific possibility. And, violà, there it is!

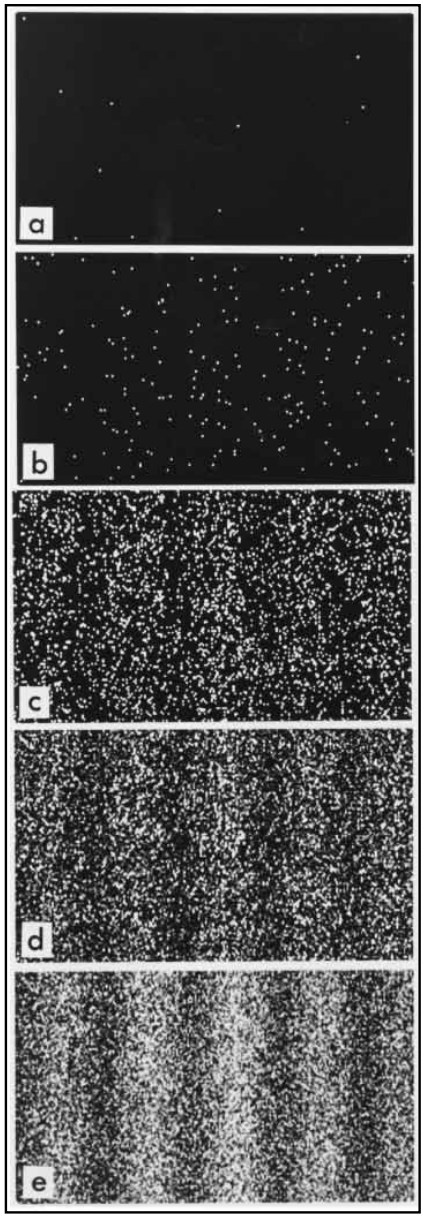
Continuing along the interface of quantum physics and Eastern philosophy, I suggest that we discard the Western concept of God as a bearded male sitting on a throne in the sky, ready to judge us before the Gates of Heaven. God cannot be described by these or any other set of specifics. He is at once infinitely ephemeral and yet highly defined; we are not capable of envisioning this juxtaposition of opposite states of "being." We can at best only move toward this vision.

Distilling this further, I believe that God is a projection of human awareness, an indefinable entity that becomes more expansive and universal as consciousness expands and evolves. To be sure, this entity—God—has existed forever and therefore before our very genesis. However, as our awareness and spirit evolve over time, so then does the presence of God. We and God are thus intimately intermingled, and we play an incredibly important role in His presence and impact within the universe. I cannot resist reiteration of Eckhart Tölle's comment, "You are here to enable the divine purpose of the universe to unfold. That is how important you are!" What unbelievable responsibility and power—as we work to expand our consciousness, we simultaneously expand the presence, purpose and reality of God! Is there anything more profound?

And so in our journey backwards in time, we can rediscover what Eastern thought has been quietly telling us for many millennia—*God is the unlimited consciousness that permeates all creation and resides as the core existence, intelligence and love within us.* ***In this respect, God truly is as an all-pervasive super-intelligence that unites everything in the universe.*** Every person, in fact every thing, has always been and always will be intimately connected.

As we ponder these thoughts, we may be rightfully perplexed, but at a certain moment hopefully amazed at the profound mysteries and paradox that grace the realm of God. As Chopra reminds us, *"God is both transcendent and immanent at the same time. So God could be considered outside us in the sense that God is transcendent to all aspects of our relative identity. But in another sense, God is our deepest essence and therefore is more intimate to us than our very thoughts."* I believe that ***God is within each of us, within all things, everywhere. Therefore, to truly know God, in quiet meditation we must look deep inside ourselves, not outside.*** I don't know how to say it any better. This is my God.

Appendix I: Electron Double-Slit Experimental Data



Exposure Time for Each Photograph Increases from (a) to (e)