

# Inside Out



Inside Out:  
Looking for Ourselves in Time and Space

By

Dana Xavier Kerola

**CAMBRIDGE  
SCHOLARS**  

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**P U B L I S H I N G**

Inside Out: Looking for Ourselves in Time and Space, by Dana Xavier Kerola

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*In Memory of Mary*



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## FOREWORD

Stephen Hawking not too long ago in 1980 had speculated that the end might be near for theoretical physicists, if not theoretical physics; He wrote that possibly in the next several decades, physicists will have completed their quest for a single theory of everything - *a unified field theory*. That search continues to be the holy grail of modern physics. Dr. Hawking even conjectures on the utility and validity of the so-called anthropic principle, which says basically that things are the way they are in the universe because of the fact that *we* are in the universe.

Whether or not there will be anything new for theoretical physicists to accomplish in the foreseeable future, or whether the anthropic principle is discoverable truth, such deep contemplations by Professor Hawking are the driving force behind the monumentally important work he and his cosmological cohorts have performed throughout the 20<sup>th</sup> century into today.

The difficult questions that theoretical physicists ask, and the profound but complicated answers they arrive at through mathematics, would serve to spark anybody's desire to join with them in their intellectual journeys. In my own ponderings of the nature of reality, I keep brushing up against those same ultimate questions. It is in that spirit that I construct this modest work.

The only way we can obtain a true picture of who we really are is by looking inside and out. It is imperative that we look inside our heads in order to find a lasting, accurate picture of human consciousness. Studies undertaken by neuroscientists and biologists everywhere are helping to unravel the deep mysteries of the brain. It is quite likely, moreover, that the preoccupation of much of theoretical physics in the 21<sup>st</sup> century will be to develop a comprehensive understanding of mental phenomena within a framework like that of quantum mechanics.

Quantum theory, now firmly implanted as the hallmark accomplishment of physics in the past century, has also taken us inside; inside the invisible and non-intuitive world of the atom. By means of formidably complex, but beautiful mathematics, quantum theorists are uncovering the secrets of the cosmos – inside and out. Looking outside ourselves, out across the almost unimaginable distances of extragalactic space, also is essential. With the use of ever-larger ground-based and space-based telescopes,

astronomers and astrophysicists, in looking farther out into the universe, are also probing further and further back in time – back to a time long before humanity arrived on the scene. By continuing to look to space, to look toward the faint clouds of gas and dust in remote galaxies, we will ultimately come full circle. We will have arrived back inside ourselves, to finally realize our origin and our destiny amidst the stars.

**PART I:**  
**LOOKING FOR OURSELVES**

# CHAPTER ONE

## WHY WE CRY

It seems like almost everything about our world has already been calculated. Within the past couple of centuries, we have been able to measure the speed of light, the size of individual atoms, the rate of expansion of the universe, and countless other quantities with astonishing accuracy and precision.

Is there anything at all left for us to compute? Perhaps there is. Here is what I would like to know: “What is the volume of the reservoir that would be filled by the pool of tears cried throughout human history by the sum total of all people who have lived on this planet?” What a supremely sad question to ask; In the liltingly beautiful theme song from the 1967 movie *Valley of the Dolls*, Dionne Warwick so poignantly confronts the question of why is it that we cry.

We cry because we die. We die because nothing can last forever. When we cry, we are reacting to a personal realization that our individual existence on Earth is finite – we cannot join together permanently with the physical universe. We cannot share an eternal happiness in partaking of the nearly boundless expanse of cosmic time. Our lives truly are so very short. Humankind has come into being so very recently. Slowly, through the inexorable forces of celestial evolution that have been acting for billions of years, *Homo sapiens* has emerged completely naturally on Earth within the last million years or so.

As far as we know, the human species is the only life-form on this planet which is aware of the passage of time. As the late anthropologist-humanist Loren Eiseley wrote in his book *The Star Thrower*:

“There is nothing more alone in the universe than man. He is alone because he has the intellectual capacity to know that he is separated by a vast gulf of social memory and experiment from the lives of his animal associates. He has entered into the strange world of history, of social and intellectual change, while his brothers of the field and forest remain subject to the invisible laws of biological evolution. Animals are molded by natural forces they do not comprehend. To their minds there is no past and no future. There is only the everlasting present of a single generation-its trails in the forest, its hidden pathways of the air and in the sea.”

Professor Eiseley's other writings as well were all tinged with a significant sadness in his tone as he so poetically reflected on his own life, and the life of humanity through the ages. In combing through his several books, I come away always with a feeling very similar to the one evoked whenever I listen to Andre and Dory Previns' *Valley of the Dolls* soundtrack composition. Dionne Warwick goes on in that title track to sing about the yearning everyone has to move ahead in their life, to move ahead into an unclear, uncertain future.

In way of introducing and enlivening many of the chapters of this book, I will endeavor to exploit some of my own remembrances of words and music, as a spring-board for explaining how each of us fits into the world, who we are, how we got here, and how we are going to get on to where we are bound.

## CHAPTER TWO

### MARKING TIME

In the 7 minutes plus 6 seconds duration of Pink Floyd's song "Time", an indelible musical image representing a quintessential fact of cosmic evolution is created within the intent listener's brain. That lengthy modern tone poem, appearing on arguably the most important progressive rock'n'roll record of all time, *Dark Side of the Moon*, tries to put into perspective how incredibly finite our lives are, compared with the relative measure of past and future existence of our own star, the Sun. The seminal British "space rock" group is unflinchingly attempting to get people to open their eyes and look at an all-encompassing physical reality governed by the inexplicable quantity called "time".

Trying to grasp time is virtually impossible, not only in attempting to formulate it theoretically and scientifically, but in even a qualitative, existential, and emotional sense, it practically defies description. An individual's life-span is so incredibly abbreviated compared with the age of the physical universe. The human mind falters when coming to grips with a true comprehension of the passage of the eons.

It is difficult enough to even just keep track of passing decades, and to make some modicum of meaning of the flow of vanishing dates across the calendar, whether for a few months or a few years. I suppose I am lucky in one sense that I happen to have inherited from my father a strong memory for keeping track of those evaporating moments. My father for that matter lived through a portion of each decade of the 20<sup>th</sup> century – sort of remarkable in and of itself. It would seem that the greatest range of a full recollection of temporal events would be not much more than about one century – a mere 100 years. So, let's use that number as our starting point for marking time's passage.

#### **One hundred years ago**

At the time I started to write this book, television coverage was reminding all of us "TV-fatigued" news viewers of the one hundredth anniversary of the great San Francisco earthquake. That California seismic

calamity happened at 5:12 a.m. Pacific Standard Time on the morning of April 18, 1906. As the local channel's video coverage showed, there were several centenarians on-hand at the commemorative ceremonies in the fabled western U.S. city on April 18, 2006 to briefly be interviewed in a typical one minute "sound-bite" filler. I happened to be watching on KNBC Channel 4 from Los Angeles. As one old woman expressed her heart-felt earliest memories of that historic natural disaster to the reporter, it occurred to me that her recall of the personal experiences she had of that terrible tragedy, establishes a real limit to what any human being can actually comprehend of past events. To look backwards in time to selected junctures, places, and events, to distant temporal points prior to what our individual recollections will provide us, we must rely on the recordings of history, accumulated by those actually living and present at the time. An archived photographic image of the burning fires, taken during the aftermath of the 1906 San Francisco earthquake, as seen from Market Street, is presented in figure 2-1 below.



Fig. 2-1.

Four years after the occurrence of the Great San Francisco earthquake of 1906, another memorable event, the recurring apparition of Halley's Comet in 1910 was experienced by many. Although it was not intrinsically geophysical in nature like the potent northern California temblor, it nonetheless exerted its own kind of power, one that would have stirred and shaken a person's mind and soul, rather than what the seismic shaking had done in physically destroying a city's infrastructure and killing many of its residents. Many people have had the good fortune in the century just past to have seen that legendary celestial dirty snowball move quietly past Earth, not once but twice. My own father, now gone, was one of them. Countless others are still living. The brooding reminiscences of Loren Eiseley, born the same year as my father, 1907, recounts how Professor Eiseley was instilled throughout his 70 years with the desire to see a second return of that cosmic messenger. Sadly, he fell 9 years short of fulfilling for himself what his own father had softly exhorted him to stay alive for.

The first of the two 20<sup>th</sup> century apparitions of Halley's Comet was more favorable to view than its return 76 years later in 1986. In 1910, America's night-skies were certainly much darker. The geometry of approach of the comet in 1910 as it neared the Sun and Earth was more suitable. It came closer to Earth than too. Curiously enough, some 4 months before Halley's perihelion, or closest approach to the Sun, an even brighter comet appeared in the northern hemisphere. In his book *Halley's Comet: A Mysterious Visitor from Outer Space*, science writer Terence Dickinson chronicles the serendipitous discovery by 3 South African diamond miners of a brilliant comet those men found by accident one morning as they ended their work shift. The object was so bright it was seen in broad daylight! That final year of the first decade of the 20<sup>th</sup> Century must have been a heavenly time for even casual stargazers.

At the mid-way mark between the Great San Francisco earthquake of 1906 and the 1910 revisit to our terrestrial neighborhood by Halley's Comet, another comet-related event occurred in desolate Siberia. Almost now exactly one century ago, a catastrophic explosion within the Earth's atmosphere, either by the bursting of a small comet or the instant disintegration of a large meteor, shattered both the natural and human environment across Russia and Eurasia. The cataclysmic cosmic collision above ground over the Tunguska River Valley was seen and felt by many across the region. The Tunguska event, as it is referred to in official planetary science circles, still is not fully understood.

It is interesting that in the purely physical universe in which we reside, purely physical objects, like comets, have produced such fear and

loathing throughout the ages. Comet Halley, because of its rather short 76-year cycle of passing by Earth, probably more than any other solar system visitor, has stirred so much excitement and emotion throughout its recorded apparitions.

Along with Comet Halley's appearance in 1910 and then again in 1986, another much-heralded comet apparition which almost fully frames the 100-year span of the 20<sup>th</sup> century, is the unique comet Hale-Bopp, which reached its closest approach to the Sun in the first week of April, 1997. My father was 90 years old by then. He was starting to slow down a bit. Knowing how he was, I am sure he did not care to even go outside in crystalline Southern Nevada skies to view it. One of the things that made Hale-Bopp so unique is that it holds the record for being the comet discovered telescopically at the greatest distance from the Sun. Its arrival had great media hoopla and public pandemonium associated with it. I personally have felt such sympathy for the co-discoverer Dr. Alan Hale, who tried so hard to present the true, unsensationalized explanation of what the comet was. For that matter, I had the same impression of how the other co-discoverer Tom Bopp felt about how the media and general public misconstrued the reality of what Hale-Bopp was all about. I met Mr. Bopp a handful of years after the comet's naked-eye prominence, one late afternoon at a Tucson telescope shop. I empathized with him and told him I had just completed some research studies concerning Hale-Bopp's dust grain particles size and chemical composition which I had performed at the University of Arizona's Lunar and Planetary Laboratory a few years before.

It bothers me greatly, as I am sure it does many others that purely natural, physical objects in the world around us can not be recognized for just what they are – purely natural and physical objects in the universe. You would think in this modern era, with scientific knowledge in general so readily available, that nobody would still be infused with scary forebodings and irrational projections of what those unthreatening celestial bodies actually are. The much publicized human tragedy that was "Heaven's Gate" certainly belies any expectation that a rational response to a cometary visitation will generally occur.

Shortly after the vernal equinox of 1997, when Alan Hale, Tom Bopp, along with countless other astronomers were readying themselves to observe the bright perihelion passage of Hale-Bopp, disturbing news flashed for a few days across our television screens. On March 26, less than a week before the closest approach of the large comet, 39 members of the Heaven's Gate religious cult were found dead in their southern California compound after a ritual suicide. Their leader, Marshall

Applewhite, convinced his followers that by consuming some lethally spiked beverage, and placing purple shrouds over themselves, the group would be carried to another world on a spaceship that the cult thought was traveling immediately behind Hale-Bopp as it drew closer into view. Suffice it to say that Heaven's Gate was sadly mistaken. There was no alien spacecraft shielded behind Hale-Bopp's nucleus, coma, or tail to whisk the true believers to their Shangri-la. It is too bad that a "shroud" of false belief continues, as it has through the ages, to hide from many people what the true beauty of the physical world is.

A photograph of Hale-Bopp is presented in figure 2-2 below, immediately before its perihelion passage on April 1, 1997. The image captures nicely the purely natural essence of the comet.

With snapshots of selected geophysical and astronomical events spanning the one hundred years of the 20<sup>th</sup> century in hand, let me take a cue from the late MIT physicist and humanitarian, Philip Morrison, who besides figuring prominently in the development of cosmology and atomic energy research, also portrayed the enormity of the universe so lucidly and compactly in his book and film, the epic *Powers of Ten*. Drawing upon what he did so exquisitely, in portraying the cosmic length scales, by stepping outward in successive multiplications by "10", from the inside of an atom to the farthest reaches of the quasars, let me proceed now in a similar way, in stepping backwards in time, to review the totality of our cosmic past.



Fig. 2-2.

## One thousand years ago

Now that our human memory marker of a single century has been characterized to some extent by way of capturing a few prominent celestial events witnessed by those still among us today, try to stretch your consciousness to picture a time dating back 10 times greater than a maximal human life-span. Comet Halley's movement in orbit was clock-work steady in its traversal of the inner solar system as it came by again to visit. But nobody alive at present (approximately 2007) was alive then. Indeed our faithful cosmic ice-ball made an appearance in 1066 A.D., at the time of the famous battle of Hastings. Of course there was foreboding experienced by the English warriors and others in the area even back then.

Twelve years prior to that single 11<sup>th</sup> century apparition of Comet Halley, another celestial event was noted, not in Western Europe, but in mainland China. On July 4, 1054, the Chinese astronomer Yang Wei-Te observed a very bright star in the eastern sky which had not been seen before. There was no mistake that what he saw was the new appearance of a unique stellar object. Astronomy in China had been so meticulously undertaken for a couple of millennia at least. The Chinese astronomers had

recorded all 17 of the earliest apparitions of Halley's Comet. So his detection of the "guest star" was not erroneous. That supernova appeared near the star in the constellation Taurus, the Bull, designated Zeta Tauri, and was as bright in the sky as Venus. It did not fade from view for over 21 months. Surprisingly there are no other written records of the event from Europe or Africa. People there, as well as in China, would have been able to see it shine brilliantly, as it did. Japanese Chronicles at the time did report the sighting. There is also a strong possibility Native Americans witnessed and recorded the appearance of the guest star of 1054. Continuing archaeological research conducted in northern Arizona since the 1950s has pointed to several Indian rock drawings which depict a large star in juxtaposition with the crescent moon, a celestial configuration which would have existed on that early July morning nearly a millennium ago.

In 1758, almost exactly 7 centuries after the apparition of the guest star in Taurus, the first observational reference to that legendary supernova's remnant was made by the French comet hunter, Charles Messier, whose compendium of "deep-sky" objects is dear to the hearts of all astronomers. In the Messier catalog, the object designated as "M 1" is now associated with the ever-expanding cloud of gas and dust known as the Crab Nebula.

## **Ten thousand years ago**

As we continue turning the crank of our cosmic time machine, let us now travel to a period 10 times further back than when the Chinese recorded the exploded progenitor star at the center of the Crab Nebula. Our journey will now have placed us at a time predating the emergence of even the earliest civilizations, including that of ancient China. In fact, our temporal transportation at this step will have taken us 2 times further back than the advent of the first cities.

Some 100 centuries ago *Homo sapiens* had still not begun living in municipalities. The reality of human life back then still involved the "hunter-gatherer" motif set in a purely natural physiographic landscape of hills and valleys, plains and pastures, and deserts and mountains. In the years centered around 12,000 BC, our semi-cultured ancestors were living in an inter-glacial period, when the planet had gradually emerged from its most recent ice age. That period of topographic deep-freeze, which had seen glaciers advance as far south to what is now the Midwestern United States, reached its maximum about 18,000 years ago.

The last ice age of 18 millennia ago was one of the coldest of the many periods of glaciation which preceded it. From 2 distinctly different approaches, it has become fairly well-established that the Earth has undergone glaciation in cycles with timescales of 100,000, 43,000, 24,000, and 19,500 years. After more than 3 decades of toiling with the subtleties of the variations in the Earth's orbit and its tilt, Milutin Milankovitch, a Yugoslavian mathematician, was able to calculate the first 3 of those cycles. The Milankovitch theory gives the periodicities as 100,000, 41,000, and 22,000 years. Several astronomers later were able to refine the predictions for the last 2 cycles (i.e., 24,000, and 19,500 years, respectively). Independent biogeochemical analyses of the almost microscopic living creatures found in lengthy ice cores, conducted principally by researchers James D. Hays, Nicholas Shackleton, and John Imbrie, have yielded the same values for the ice age recurrences.

### **One hundred thousand years ago**

Walking backwards now to a point on the cosmic calendar 1000 maximal human life-spans ago, we arrive at a point most likely climatically similar to the time of the most recent ice age of nearly 10,000 years ago. Furthermore, at this anthropologically formative juncture, *Homo sapiens*, as well as *Homo habilis* and *Homo erectus* would have still been in a hunter-gatherer mode. At that point in time, approximately 1000 centuries ago, the hominids of the Stone Age flourished.

In the last chapter of his book, *Earth History*, James C. G. Walker discusses the cultural records which have been archeologically preserved in the form of the Acheulian assemblages of stone tools. The Acheulian hunters, believed to be representative of *Homo erectus*, used big tools such as hand-axes and cleavers for the cutting and chopping of their dietary staples – large game and vegetables.

An amazing attribute of the Acheulians was their long-term stability. They persisted in East Africa with little change in their culture for a period of about a million years with a culmination on that continent about 200,000 years ago. In Western Europe, their demise was as recent as 100,000 years ago. They evidently lived in small groups. During times when the food supply was plentiful, the population was widely dispersed across the tropical savannahs of East Africa or grasslands in Spain. During the recurring ice ages, their populations, consisting of different groups, became more clustered in denser settlements, permitting strong interbreeding. It is thought that the alternating periods of dispersal and

clustering of the Acheulians might well have accelerated the biological evolution of modern man.

### **One million years ago**

The date of the origin of humankind in a form comparable to what we know it to be today is not known precisely. Anthropologists are nonetheless able to trace the earliest appearance of *Homo sapiens* to a time nearly 10 thousand centuries ago. That span, measured from today back to that dim past, equals  $10^6$  (i.e., “ten raised to the power six”) years – 1 million years!

Five times further back than that, about 5,000,000 years ago, paleontologists are reasonably certain there existed an abundance of apelike creatures referred to as *Australopithecus africanus*, or the gracile Australopithecines. Not quite as old as that, another kind of Australopithecine, *Australopithecus robustus* has its earliest existence dated to about 3.7 million years ago. Neither of these 2 kinds of Australopithecines was of the biological genus *Homo* – i.e., they were not human. They were creatures who did not yet completely navigate upright on 2 feet (i.e., they were not completely bi-pedal), and they had brain masses only about one-third of the average human brain of today.

Although there always remains some debate about what the precise delineation of the actual evolutionary course was, apparently the first true man arose concurrently with *Australopithecus robustus*. This new animal, *Homo habilis*, had a ratio of brain to body weight commensurate with that of the gracile Australopithecines, and was larger in total size than either of his Australopithecine collateral relatives. Perhaps the most important thing to note regarding the advent of *Homo habilis* was his completely bi-pedal locomotion. Certainly one of the foremost defining traits of *Homo sapiens* when he arrived on the scene 3 million years after *H. habilis* is that modern man walks erect. The first evidence of that characteristic, appearing in the overlapping co-existence of the various hominids of a few million years ago, lay in the discovery on the African savanna of *Homo erectus*. His stance was upright. His body and brain were larger and more manlike than his Australopithecine predecessors.

### **Ten million years ago**

At this stage in our recollective journey, we have receded so immensely beyond the scope of our human lifetime measuring stick, that it is almost meaningless to say we now are positioned at a time equal to 1

million decades ago. Human memory is just barely up to the task of grasping a period equal to 10 decades – but, a *million decades!* I think not! We are so far removed at this point from a time which saw the presence of anything even quasi-human. We are now situated twice as far back as the temporal separation between modern man and the gracile Australopithecines. Only primate tree dwellers were present to occasionally turn their eyes and small-sized brains skyward through the terrestrial forests which were their habitats. It is debatable whether there was really a truly conscious earthly entity at that particular time to understand what lay all around itself, either on the ground or in the sky.

Nevertheless, terra-firma and the surrounding firmament *were* present. The Earth was continuing to evolve, and its land-forms and atmosphere were continuously changing. Biological changes were happening as well. Mammals, primates, and plants were undergoing mutations to eventually become life-forms of ever-increasing complexity. But, in our planet's specific location, at that time ( $10^7$  years ago), at its specific place in the Galaxy, there was still no mechanism by which that particular bio-geophysical evolution could be witnessed. Human consciousness had still not arrived.

Although they would not probably have known what they were looking at, the mammalian creatures present 10,000,000 years ago, would have been able to see in the sky, in the constellation of Taurus, displaced not too far from where the Chinese glimpsed the guest star of 1054 A.D. approximately 9,999,000 years later, an evolved star cluster known as the Pleiades, whose brightest 7 stars would have then (as they are for us today) been visible with no extra optical aid than that of our naked eyesight.

Quite young when measured by the astronomical clock, the beautiful assemblage of bright blue stars known as the “Seven Sisters” is actually a gravitationally bound grouping of some 300 stellar objects born about 50 million years ago. The Pleiades, another one of Charles Messier's famed nebulae, is designated in his catalog as M45. Referred to as an *open* cluster, this magnificent telescopic sight lies about 400 light-years from Earth. Strewn throughout the space occupied by the cluster are small particles of dust, which show up on astrophotographs as a bluish-colored reflection nebula. The light from the predominantly hot blue stars in M45 is scattered by the embedded interstellar grains.

## **One hundred million years ago**

By now we have receded to a place in time 100 times further back than the dawn of modern man. On biological and geological timescales

we are exceedingly regressed. Yet, on the cosmological clock, the dawn of the universe itself is still more than 100 times further back than that!

At this point in our travels, we are definitely so far back in time that no such phenomenon even remotely resembling human consciousness exists. We are in an epoch preceding mammals. Yet life was replete on Earth. It was the age of the reptiles and dinosaurs, the *Cretaceous* period. The non-living component of the planet was active too. Plate tectonics, or the drifting of continents, was producing the break-up of a once global-sized land mass, Pangaea. On top of all of that, the Earth's climate 10<sup>6</sup> centuries ago was quite warm. Does that sound familiar?

Geologists fully think that the climate 100,000,000 years ago was like a hothouse everywhere, even in the polar zones. A very plausible theory to explain why our planet's surface and lower atmosphere heated up so much then involves the break-up of Pangaea. As that proto-continent was being disrupted, the oceans were opening up and new sea floor was being created at quite a rapid rate. The tremendous amount of sea floor spreading resulted in enhanced volcanic and seismic activity. Volcanoes would have released massive amounts of gas, much of which would have been carbon dioxide (CO<sub>2</sub>). That vast infusion of CO<sub>2</sub> into the air would have been possibly enough to heat up the planet's lower atmosphere.

The Cretaceous period marks a time of the greatest contrast in terrestrial temperatures between then and now. Global averages then were about 6° to 12° centigrade warmer than today. Even during a major ice age, the average temperature was only cooler than today's by about 5° centigrade. The hothouse was hotter than the icehouse.

## **One billion years ago**

Transporting ourselves 10 times further back than the geologically interesting Cretaceous period, we are now coming to a point equally intriguing on an astronomical timescale. Some 10<sup>9</sup> years ago, there was still plenty of geological activity, but not all of it was restricted to changes only to the body of the Earth. The inner Solar System was at a point in its evolution that the intense bombardment of its inner reaches, including incessant collisions of planetesimal material with Earth and the Moon, was only then beginning to wane. Heavy cratering of the lunar surface from the cosmic collisions occurred until about 1,000,000,000 years ago. The same would have been true for Earth itself. Giant craters ringed with 10,000 ft. high rampart walls would have been produced. But in the course of about one hundred million years (a span we have now sort of come to grips with), any remnants of such 2 mile high mountains of rock on Earth

would have been completely eliminated by atmospheric and surface erosions. On our Moon though, because of the absence of any atmosphere or fluids on its surface, the cratering record has been preserved. Toward the end of this book, I will discuss the Moon's history in greater depth, and show the intimate connection Earth has with its only natural satellite.

As far as biological activity was concerned, our planet 1 billion years ago, was at a point on our cosmic clock a thousand times further back than when *Homo sapiens* first evolved. The only life on Earth was in the form of multicellular creatures. The grouping together of single cells to form more complex biological structures was a major evolutionary step at that incomprehensibly distant time 10 million centuries ago. Once individual cells grew to a certain size through the ingestion of the ambient organic matter, monocellular life-forms could no longer acquire enough nourishment to sustain themselves. Evolution's reaction to that stumbling block was to limit the volume of each cell, and instead have the cells clump together to augment the total surface area of the system. As the single cell creature would grow, its volume increased faster than its surface area. It is the surface area of the cell which determines how much food can be absorbed. So in coming together in small colonies, the first multicellular organisms (e.g., sponges, and later, jellyfish) could thrive.

### **Ten billion years ago**

We now reach a point where we have covered most of cosmic history in jumping backwards by multiples of 10. By way of our cerebral gymnastics we have now spanned  $10^8$ , or 100 million centuries. The universe 10 billion years ago probably had no life present anywhere to ponder itself. Our Solar System, with its Sun, eight planets, Pluto, and the asteroids, was still 5 billion years away from even coming into existence. Nevertheless, the Milky Way Galaxy, in which our stellar and planetary system was later to reside, had formed then, along with countless billions of other galaxies in the known universe.

## CHAPTER THREE

### THE CONSCIOUS WORLD

Each of us inhabits a world seemingly completely divorced from the physical reality of planets, stars, and galaxies. Appearances can be deceiving however. That inner world in the minds of many human beings is a self-delusional realm. In truth, all of the people on the planet, each with their independent thoughts and dreams, are not so separate from each other as they might think, or from the planet itself. In truth, human beings are intimately connected through time and space with the Earth itself.

One thing all of us can agree upon at the outset is the fact that human beings themselves do not have unlimited powers. We are born and then we die. We are not able to live forever. We have not created ourselves. Man did not create the ground upon which he walks. Some mysterious energy or force precedes us, and gives rise to our own existence. That force is physical. So why is it then that religionists continually resort to some vague, nebulous notion that humanity is defined by a spiritual essence, that each of us is somehow ethereally elevated above the physical world, as if individuals, singly and collectively are living their lives completely detached from the ground upon which each of them walks. Why do these same religionists also always invoke a personified, supernatural being, a *deity*, to try to overshadow and hide from view what is a purely natural, physical cosmos? We are a natural, physical product of the physical universe which preceded us, and we are residing inextricably within that material world. Nothing that the human brain senses and records in its memory lies outside of space-time. Our consciousness of the external world is manifested as we live, breath, think, and feel within that same world. In addition, Einstein recognized as well, that the world is whatever it is regardless of whether we ever come to know what it is. In his *Autobiographical Notes* he wrote:

“Out yonder there was this huge world, which exists independently of us human beings and which stands before us like a great, eternal riddle, at least partially accessible to our inspection and thinking. The contemplation of this world beckoned like a liberation ...”

Philosophers have debated for ages the so-called “mind–body” duality, predicating their discussions on the premise that there is somehow a necessary distinction or contradiction between what is on one hand a “physical” world and separately, on the other hand, a “mental” world. Realize, however that mankind and its consciousness, or its mental realm, has come into existence long after the non-mental world was already there. So the “physical” takes precedence over the mental, in that the physical universe represents the fundamental reference frame in which to assess reality itself. Closely akin to that realization is the fact that there would be no mental world with all of its psychological attributes, if there were no physical universe. That is to say, there would be no such thing as religion, or the notion of God, or the supernatural, or the paranormal – everything would be physical. John Lennon, in his phenomenally beautiful solo song, “Imagine” invites the listener to consider exactly that point of view, when he conjures up the possibility that there might not be any firmament, but only an astronomically defined “celestial sphere” surrounding us rather than some religiously defined concept called “heaven”.

The great English astrophysicist Sir Arthur Eddington, a towering giant in the fields of stellar structure and relativity, erases the mind-body dichotomy. He sums it up beautifully:

“The recognition that physical knowledge is structural knowledge abolishes all dualism of consciousness and matter. Dualism depends on the belief that we find in the external world something of a nature incommensurable with what we find in consciousness; but all that physical science reveals to us in the external world is group-structure, and group-structure is also to be found in consciousness.”

From what has been established so far in my writings here, it would seem that the only appropriate paradigm for the true study of consciousness would be that of physics. Modern theoretical physics has been quite successful to this point in being able to chronicle the history of cosmic time. Kip Thorne, one of the most notable blackhole theorists of our day, in his monumental popularized treatment of Einstein’s General Relativity, *Blackholes and Timewarps*, tells us: “A paradigm is a complete set of tools that a community of scientists uses in its research on some topic, and in communicating the results of the research to others.”

The scientists in the early decades of the 20<sup>th</sup> century who laid the foundations for our present-day paradigm of the universe - quantum theory, also devoted their deep thinking to ponderings on the nature of consciousness. Erwin Schrödinger, the creator of the quantum mechanical

wave equation, in his book *Mind and Matter*, poses the quintessential problem. He writes:

“The world is a construct of our sensations, perceptions, memories. It is convenient to regard it as existing objectively on its own. But it certainly does not become manifest by its mere existence. Its becoming manifest is conditional on very special goings-on in very special parts of this very world, namely on certain events that happen in a brain. That is an inordinately peculiar kind of implication, which prompts the question: what particular properties distinguish these brain processes and enable them to produce the manifestation? Can we guess which material processes have this power, which not? Or simpler: what kind of material process is directly associated with consciousness?”

In order to lay a rational, systematic foundation then for the new scientifically-based exploration of the nature of consciousness, we must start with its physical repository, the seat of that consciousness - the brain. In the previous chapter I have taken you on a re-collective journey, chronicling the natural history of the universe. To grasp those cosmic epochs required great mental leaps back through past time, periods of time in the life of the universe that predate *Homo sapiens*' memory, individually and collectively. To come to grips with the riddle of how we understand the past (or the future for that matter), we first need to know something about the amazing biological apparatus we use to represent it.

The functioning of the human brain and its associated activity – *consciousness*, remains to this day still the greatest of mysteries. How is it, that inside one's skull, in an oval-shaped region of gray matter weighing only a few pounds, such intangible, inexplicable phenomena like thoughts, memories, dreams, and emotions occur? Moreover, what is it that is happening inside of us, and to the universe outside of us, when we think, remember, dream, or release our emotions through laughter or tears? Only by using the very same instrument, the brain, which gives rise to those ponderings, can we construct answers to such questions.

Consciousness itself does not seem to be material, yet consciousness occurs *within* the material world. In our computerized, virtual reality of today, with pocket global positioning system (GPS) receivers, we can pinpoint where any person is located at any given time. Now realize that at any given time, that same person and his or her brain is not located outside of space-time itself. Furthermore, consciousness has no mass. But neither do photons of light have any mass. One person's memories of his or her own life are not ever the same memories as are another person's memories of that person's own life. Yet the *same* process occurs, in the same neurophysiologic way for each individual in how the memories of perhaps