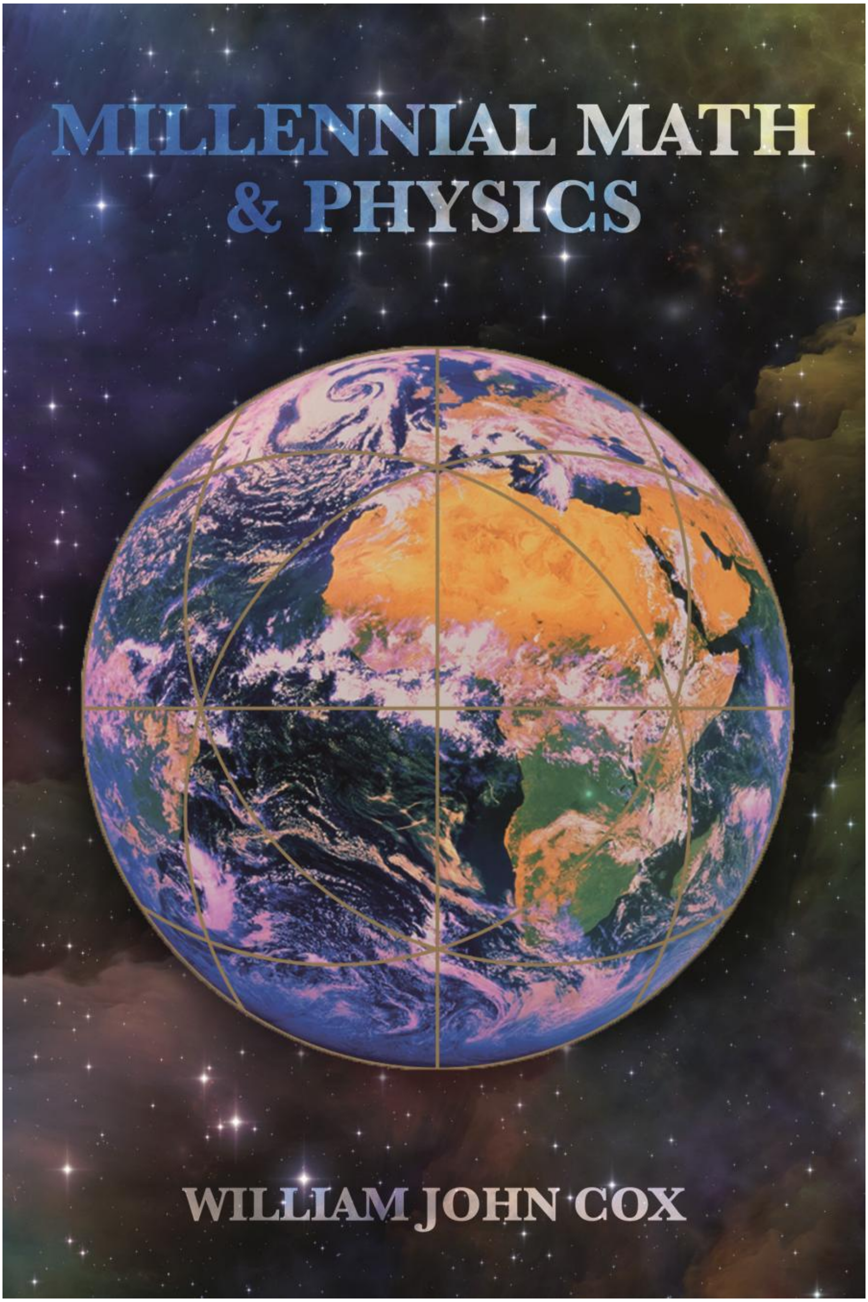
MILLENNIAL MATH
& PHYSICS
WILLIAM JOHN COX

Millennial Math & Physics

With A Book-Length Appendix
Time Travel to Ancient Math & Physics

William John Cox

Mindkind Publications

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Dedication

Among my earliest memories is the time shortly after my mother died, when I was four and my father had taken me to his bed to sleep. In the evenings he would often read dime Western novels and, after I grew bored with looking at the covers, he taught me to read.

I also remember sitting beside my father under the old cottonwood tree at the edge of our vegetable garden one warm evening, as we were cleaning fresh carrots. We were looking up at the big star-studded West Texas sky, and he was pointing out the various constellations he recognized. As best he could, he was trying to explain to a questioning farm boy how the Earth, Moon, Sun, and planets moved and how they were all related.

My father died when I was ten—before I could absorb very much of what he had to teach. Since then, I have sought to learn what it was that he himself hungered to know, and satisfying that need became a duty compelling me over the years to finally complete this book.

Inspiration for this work comes from my father, Samuel Hubert Cox; however, its spirit is dedicated to the Children of Mindkind on Earth, who must learn the lessons of history and grasp the science, physics, and mathematics of the future. It is their duty to chart the cosmos, and it is their destiny to discover other precious warm-water planets where life can thrive and creation can continue.

We now stand at the edge of the mind field of time,
and we are just beginning to surf the waves of information
along the seashores of space
and to cast our net upon the wisdom of eternity.
To sail onward, we must accept that
our minds have become intertwined,
and that unity of mind must be the universal trait
which binds us to all other sentient beings, everywhere.

PREFACE

The year was 1982. I was 41 years old, worn out and weary from fighting a high-profile *pro bono* legal case for more than a year.

Ten years of practicing law, both prosecuting and defending criminal cases, brought the realization that practice didn't always make perfect. There were not enough hours in the day to care properly for the problems of the endless stream of unfortunate and desperate individuals who found their way to my doorstep.

The justice system was in the process of being reoriented from rehabilitation to punishment. Compassion and discretion were increasingly limited by statute, and density, rather than warmth, was becoming the measure of the hearts of those who judged.

Behind locked office doors with the phone turned off, I reflected upon my life before the practice of law. I recalled a slow, lazy summer spent hanging out on a California beach watching sunsets, tracking the pace of the moon, anticipating where it would appear each evening, and keeping an eye out for Venus and other planets, for Orion and Sirius, and for the North Star.

As I recovered my strength, I recommencing my fantasy trips to the stars and spent a year in my mind traveling about on light waves, peacefully floating along in space time enjoying the view.

Over dinner one evening, looking at a candle across the room, I imagined a series of light waves flowing from the flame, washing against my nose and being reflected back toward the candle.

Since the waves, both coming and going, were all traveling at the speed of light, I wondered if they were approaching each other at twice the speed of light, just like two cars, going in opposite directions in the same lane on a highway traveling at a safe 50 miles an hour, who close their separation at a catastrophic 100 miles per hour?

Einstein's theory of relativity says no, but sitting in the quiet restaurant, I imagined our entire perceived universe must necessarily move at some speed on a curve in relation to some other mass.

Logic then suggested the other mass must move in relation to yet another mass, which also moves, and that all matter is probably governed by the speed of light within its own system of mass. However, the image of multiple moving universes led to further questions.

If our universe is in motion, how fast is it moving? Could it be moving at or near the speed of light in relation to other mass?

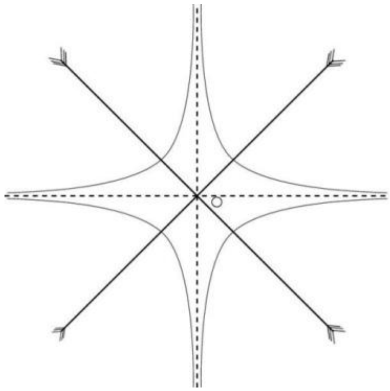
Imagine a young child running along the beach at the edge of the water, holding a holiday "sparkler" in her hand as she waves her arm around in circles. Our universe can be seen as just one of the tiny sparks, drifting in her wake.

Consider the nature of the "wake" within which everything in our universe moves, including Earth. Is it possible the combination of neutrinos, alpha, beta, gamma rays and all other subatomic particles and sparticles, light and dark, known and unknown, sufficiently occupy and distort all space-time as to provide the plastic structure required for the transmission of light, gravity waves, and the particles themselves? If so, does the "force" become its own "field?"

Finally, has the "collective consciousness" of humanity arrived at a plane where our common mind becomes capable of logically understanding the external forces that act upon our universe in the absence of experimental evidence of their existence?

If we are to ever go to any *significant* place within this universe or in time, or into its adjacent dimensions, or to more fully understand the mechanics by which it operates, mustn't we acknowledge that it is no longer possible for any one individual to contain within her or his own mind all that has to be known and understood to do so?

If so, is the "Mind Field" the medium within which the forces of collective consciousness will act in the future to propel our children through time, adjacent dimensions and beyond the universe? Can the "Mind Field" reflect or transmit the beacon required to safely guide them on their way home?



To help answer these questions, let us imagine a geometric structure within which to contain multiple universes. We can start with a simple cube having six sides and eight corners.

The inner space of the model can be contracted by focusing multiple hyperbolic curves inward along eight vertices drawn from each corner to the center, and the space can be reduced to zero as the curves move uniformly to the middle of the cube and beyond.

Substituting sets of simple curves to illustrate convergence of the hyperbolas, and then moving the curves through and beyond the center, provides a glimpse of the other side of nothing, once the curves begin to expand.

These curves can be demonstrated on the surface of an expanding sphere (inflating a balloon) by inscribing it with six great circles, which divide the surface into 24 equal right-angle spherical triangles. Defined by 14 vertices, the triangles have perimeters of exactly *Pi* times radius; however, the exact ratio of the sides to the hypotenuse of each triangle aroused my curiosity.

Years passed as contemplation of these spheres and careful measurement of the triangles led to the construction of a number of physical models.

Repeated observations finally led to the conclusion that the ratio of the sides of the triangles was probably 3:3:4, with a height of 2.5; however, mathematical proof remained elusive.

Fortunately, as the Internet continued to grow, several sites providing self-help spherical trigonometry formulas came online. These formulas ultimately provided the ability to confirm observations of the 3:3:4:2.5 ratio with mathematical precision. A final model using these ratios was constructed.

In some ways, imagining a *Millennial Geometry* to contain moving universes was entertaining, although the effort involved in the physical construction of models was both laborious and exacting. However, demonstrating the proportional length of the sides of the *Pi*-based geodesic triangles using base-10 mathematics posed continuing difficulties.

One day while sitting in a hotel room gazing out at the Capitol building in Washington, D.C., again seeking refuge from the practice of law, I imagined expanding our numbering system to base 12 by adding a "U" after three and an "N" after six, for the square and cube of two. I later extended the system to base 16 by adding a few more symbols: 1,2,3,U,4,5,6,N,7,8,9,S,C,X,W,10.

After making some hand calculating tables and solving a few problems, great harmony was found in *Millennial* numbers, including the values of *Pi,* the Golden Proportion and other mathematical standards. One interesting discovery was that *Millennial Pi* essentially rounds itself off at the 7th, 8th, and 9th place, 3.2U3W58NNN, resulting in a very useful expression of *Pi* for most practical purposes.

Millennial Math was also found to contain subsets of some very elegant little numbers, which do not exist in a rational form in base 10. These numbers, especially 0.12UN, provide the foundation for a highly logical numeric system.

Now, after more than 30 years of contemplation, these ideas are collected in this book, which is being offered in celebration of our human achievements thus far and the new millennium we are entering.

We are fortunate to live at a time when sciences, such as archeology, geology, paleontology, biology, and linguistics are providing reliable clues as to the nature and character of our ancient existence. We are, however, less able to predict the future, and we can only guess at what it holds.

Humans have walked on the Moon, and there is talk of a manned expedition to Mars; however, in the grand scheme of things, these are only baby steps.

Over the past 6,000 years, our civilization has been built with the basic tools of physics, geometry, and mathematics. While there have been dark ages and times when knowledge was lost, destroyed, or misplaced, we survived, and we have progressed to this unique place where we have the opportunity to build a bridge from the past into the future.

To do so, we must comprehend not only the nature of matter and how to measure and count it, but we must come to have a better understanding of ourselves, how and why we think, and what is most important.

Then, and only then, our children, and theirs, will be ready to peacefully fly to the stars—and far, far beyond. Not only will they be reunited with their cousins in the Family of Mindkind, but they will also discover other warm water planets upon which to build nests for the next generation of the Children of Mindkind.

"To raise new questions, new possibilities,
to regard old questions from a new angle,
requires creative imagination and
marks real advances in science."
Albert Einstein

THE COURAGE OF GALILEO

Broken in health and nearly blind from years of studying sunspots and enduring cold, wet nights gazing through his telescope at what he called the "starry messengers" of the heavens, and terrorized by the threat of torture, the old man was led into the great hall of the Inquisition and forced to kneel before the cardinals of the Holy Office.

Accused of heresy for "having held and believed that the sun is the center of the world and that the earth is not the center and moves," Galileo Galilei (1564-1642) was handed a document and forced to "abjure, curse, and detest the aforesaid errors and heresies."[1]

These brief facts are contained in Vatican papers dated June 22, 1633; however, legend has it that, as Galileo rose and turned away to spend the remainder of his life under house arrest and forbidden to ever speak again on the subject, he murmured, "*Eppur si muove*" (Italian: nonetheless, it moves).[2]

Lest we question the courage of Galileo, let us not forget the fate of Giordano Bruno (1548-1600), who had been burned at the stake only 33 years earlier for having published a paper, *On the Infinite Universe and Worlds*, in which he speculated that the sun was only a minor star for which God had no particular concern.

Though isolated until his death, Galileo was not alone. Throughout the world, thoughtful individuals relied upon the telescope he popularized and the methods of scientific inquiry he

[1] I have always felt honored to share February 15th as a birthday with Galileo.

[2] For a highly entertaining "Historical Memoir of Science, Faith, and Love" see Dava Sobel's *Galileo's Daughter* (Walker & Company, 1999).

established to move the earth from the center of the universe, in their minds, and to put it in proper motion around the sun.

With the advent of the Age of Discovery, these individuals made their own contributions to the collective human intelligence, in the form of scientific observations and new mathematical tools of calculation. And, once the genie was out of the bottle and observations confirmed theories, no thinking individual could ever again imagine the earth as a flat plane around which revolved the cycles and epicycles of the heavens.

Much that was discovered had been known to ancient civilizations. Early on, we not only realized that the earth was a round, spinning sphere that revolved around the sun, but we were able to chart the heavens and the surface of the earth with great accuracy.

Most of our ancient knowledge was lost in its translation to the classical Greeks, who seized upon the geometry, but failed to learn the physics, or to comprehend fully the mathematics.

In the Fourth Century C.E. the Roman emperor, Constantine, paganized the Christian Church, and soon thereafter the Church adopted the Greek's earth-centered view as a matter of dogma. Then, there was only ignorance and, with the power of the Roman Catholic Church to suppress any contrary views, the West had to wait through more than a thousand years of dark ages before it could again see the light of reason.

The heroes of the Age of Discovery were those who risked the eternal damnation of their souls to pursue the truths they saw with their own eyes, and it was not until 1992 that Pope John Paul II finally admitted the Church's error in having silenced Galileo.

Whether or not Galileo actually climbed the leaning Tower of Pisa and demonstrated that objects of different weights dropped at the same time would hit the ground at the same moment, it is known that he constructed inclined planes down which he could slowly roll round metal balls of different weights, allowing him to carefully time their trips with water clocks.

Galileo was able to demonstrate that all free falling objects will fall the same distance in the same period of time, and that they all also share the same rate of constant acceleration. Since then, the word *acceleration* has been understood and defined as the rate of change of velocity, while *velocity* is described as the rate of change of position, such as 30 miles per hour.

Although confined to his home and forbidden to speak about the mechanics of heavenly movement, Galileo spent his last years completing and publishing *Discourses on Two New Sciences*, on the safer subjects of optics and pendulums.

Upon his death in 1642, Galileo became the spiritual "father" of the science of physics, and within the year, his intellectual "son" was born in England.

THE GENIUS OF NEWTON

Isaac Newton (1642-1727) was able to learn from and to build on the contributions of Galileo and others, as he said, to "stand upon the shoulders of giants" in order to see further. Newton's vision allowed him to formulate several simple laws of motion and gravity. Equally important, he also created the calculus, a mathematical method for organizing and calculating the multiple levels of interrelated equations required to accommodate continuing rates of change in both velocity and position, all relative to time.[3]

Momentum

Once mindless mass begins to move, it continues in a straight line (that ultimately becomes a great curve) with a linear momentum simply calculated by multiplying its mass times its velocity.

Mass can also spin about its own center or about other mass with angular momentum. A bowling ball displays both types of momentum as it both rolls and spins down the alley toward the pins,

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[3] Much of the background material for this and the next two chapters was drawn from three excellent books written for the information of lay persons: Gribbin, John and Mary Gribbin, *In the Beginning: After COBE and Before the Big Bang* (Little Brown and Company, 1993); Spielberg, Nathan and Byron D. Anderson, *Seven Ideas That Shook the Universe* (John Wiley & Son, Inc., 1987); and Speyer, Edward, *Six Roads From Newton: Great Discoveries in Physics* (John Wiley & Son, Inc., 1994). Whenever I became lost—which was not infrequent—I would pick up Isaac Asimov's *Asimov on Physics* (Avon Books, 1976) to guide me through the thicket. So, gentle reader (as the late Dr. Asimov would say), should you find my elucidation unrevealing, please refer to these primary texts and please forgive my inability to better explain that which so often seems more like a dream than reality.

and—depending on its "English"—it hopefully curves as the bowler intends.

Angular momentum is always constant in the universe and can be calculated from the mass of a body, its velocity of turning, and the average distance of its parts from the axis or center about which the turning takes place.

The Laws of Motion

While Galileo demonstrated that all falling objects fell at the same constant rate of acceleration, Newton established that the rate of acceleration was due to the effect of gravity measured as a square root of the distance times the mass.

Whether or not he conceived of the law of gravity after being struck on the head by a falling apple while sitting under a tree, Newton used Galileo's rigorous methods of scientific observation and his own enormous comprehension of mathematics to precisely state his theories in a way that was useful to others. These laws were invaluable in resolving a wide range of physical phenomena encountered during the industrial revolution.

The first of Newton's laws was built directly upon Galileo's observations and concerned the inertia of mass. Aristotle had believed that the natural state of mass was to be at rest and that it took a constant force to keep it moving. Galileo and Newton turned this argument on its head and proved that the natural state of mass is one of constant velocity.

For them, mass inherently possesses inertia, and any change in velocity is the result of an intervening external force. Pretend you are driving a car at a fairly high rate of speed with Newton's apple lying on the front seat beside you when you suddenly have to slam on the brakes to avoid an accident. Your safety belt should restrain you, but the apple will continue to fly through the air at the same speed you are going and in the same direction you are traveling and will probably smash into the dashboard.

The brakes are a force operating on the inertia of the automobile, the safety belt is a force acting upon your body, and the decelerating dashboard becomes a bruising force acting upon the apple.

Newton next dealt with acceleration in response to an intervening force that changes the state of motion or momentum of mass. Since momentum results from the multiplication of mass times velocity, and we assume that the amount of mass remains fixed or constant, any change in momentum means there is a change in velocity—which Newton defined as acceleration.

Newton concluded that acceleration of an object with fixed mass was proportional to the intervening force, and that the resulting vector will follow the direction of the intervening force. For heavy objects, such as ships and automobiles, even a small increase in velocity will produce a large increase in momentum.

The third of Newton's laws on motion states that the force exerted by one object on another is equal in magnitude and opposite in direction from the force exerted by the second object on the first. Simply put, the earth and its moon are equally attracted to each other, and were it not for each other, their love would not exist, and there would be no laws of motion to govern their mutual affection.

It is the interaction of an individual body with another that produces the concept of force, and they both act, equally, upon each other. A child riding a bicycle along the sidewalk provides three examples of action and reaction—between the child and the pedals that drive the chain, the chain and the rear wheel, and the wheel and the sidewalk, whose reaction force is what drives the bicycle and child forward. In the same manner, a rocket engine uses force to expel high-speed gases from its exhaust, and the gases exert a reaction force against the rocket to drive it forward in the vacuum of space.

The Conservation of Mass and Momentum

In combination, the three laws of motion give rise to two more physical laws concerning the conservation of mass and momentum. The first says the total quantity of matter is constant within a closed system, and while matter may change its form, such as wood to smoke and ashes, the total remains fixed. While certain violations of this law ultimately appeared, such as the results of a nuclear reaction, the second law concerning the conservation of momentum thus far remains inviolate, even at the atomic scale.

So, when two bodies, each with its own momentum collide, their total momentum will remain the same. Thus, while one may come away with greater momentum, the other will always have an equivalent lesser momentum. This is true whether we are talking about the meeting of two galaxies, two subatomic particles, two cars at an intersection, or a baseball bat and ball.

The Law of Gravity

The last of Newton's physical laws was built upon the laws of motion and conservation and related to the attractive "force" of gravity on mass. Most simply it says that the "gravitational force" between two bodies is along a straight line connecting their two centers. The force is directly proportional to the product of their multiplication and is inversely proportional to the square of the distance separating their centers.

Thus, if we can imagine gently bringing the earth and its moon together so they barely touch, we can calculate their gravitational attraction for each other by first multiplying the quantity of their masses, and then by finding the distance between their two centers. As we slowly move the moon back out to where it belongs, each time the distance between their centers is doubled, the attraction is not cut in half, but is decreased by the square of the distance, or the distance multiplied times itself.

Another way of looking at gravity is to imagine that directly above our head is a column of air that extends outward in a straight line to the edge of the earth's stratosphere. The weight of this column of air is heavy, so heavy in fact that, was it not for the fact that we are surrounded by our skin pushed outward by the atomic and electrical force of our cellular innards, we would be squashed like a sealed tin can from which the air has been removed.

We can experience the same phenomenon if we dive to the bottom of the ocean. The weight of the water above us is much heavier than air, and, if we are not surrounded by a sufficiently strong submarine, we will be crushed. If, however, we were able to dig a well-hole straight down to the center of the earth, our weight would decrease as the depth increased since there would be less and less mass below us, until we would become weightless at the center, as would be the column of air above our head, since there would no longer be any mass between us and the center against which to be "pushed."

To the extent that "gravitational" forces are perceived as operating in straight lines, they can also be seen as centrifugal forces such as those demonstrated by a slingshot being whirled around with a stone at the end, and its inverse centripetal force, operating down the string to the hand, causing it to move in circles. Each of these forces is an expression of the foundational laws of inertia and momentum.

While we have reviewed these laws of motion, conservation, and gravity in the more familiar context of the planets, stars, and galaxies, the laws hold true for all mass, no matter how small. Thus, let us next consider tiny waves of light, where they come from, and how they travel.

LIGHT, THE MESSENGER OF MASS

Imagine our entire universe is a limitless dark and cold void, illuminated and heated only by a single ancient, eternally burning, tallow candle with a linen wick at its center. Imagine the light can be seen with sufficient magnification, faintly flickering, from every direction at every distance, though neither the wax nor wick, nor surrounding atmosphere could be perceived. However, the message of its flame can be deciphered by sufficiently sensitive sensors of its spectra at every extreme distance imaginable within our perceived universe as a unique chemistry of animal oils and vegetable fibers burning in an atmosphere primarily consisting of nitrogen, with just enough oxygen to allow the twisted linen to burn.

What we would see are the waves of candle light, conveying the message of its combustion in every direction across the endless sea of time, and what we can also imagine is that the globular halo of the tiny flame is virtually as large as our entire perceived universe.

Electricity and Magnetism, the Siblings of Light

Early in the Age of Discovery, experiments with electricity and magnetism proved that the flow of electricity creates a surrounding magnetic field, which establishes itself through the surrounding space at the same speed as light.

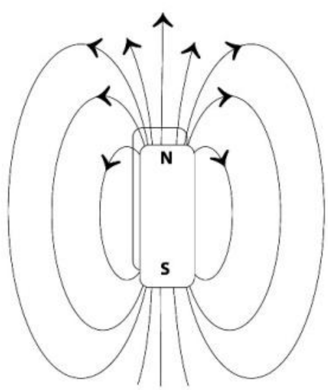

Figure 1

A picture of the nature of electricity and magnetism was provided by Michael Faraday (1791-1867), a nonscientist with a vivid imagination, who was able to "see" that electric fields operate like rubber bands. The lines of "force" between the positive and negative charges are tightly stretched under tension, "attracting" each other along their lengths, while at the same time the bands, or field lines connecting the charges also tend to push apart from, or "repulse" each other as they all share the same "in-between positive and negative" electric charge. Figure 1 demonstrates the field lines of a bar magnet.

If a wire is made to carry an electric current, a magnetic field will be generated around it, and the magnetic effect generated by the moving charge is perpendicular to the direction of electrical motion. Faraday wondered about the effect of bringing a magnet into the field near a wire carrying a current. He discovered that a magnet placed near a thin wire carrying an electric current would push the wire sideways.

Faraday also found that a magnet placed near a wire, without an electrical charge, would not generate a current in the wire, unless he moved the magnet. However, when he moved the magnet, he was able to detect a slight current of electricity in the wire.

Faraday then constructed a device that allowed him to rotate a loop of wire between the poles of a magnet and found he was able to generate a continuing electric current. These same principles are still used today to generate electricity, and conversely in electric motors to produce motion.

The paths taken along these field lines are known as geodesics—which simply means the shortest possible path, given the forces operating on it. In the same manner, water running downhill will always seek the shortest path and will act upon the earth by erosion to continually shorten the distance.

Pierre de Fermat (1601-1655) had earlier determined that refracted light operated in a similar manner. He concluded that light will always move between two points in the shortest time, versus the shortest distance. Light will find a short path through water or glass lenses where it is slowed down, but can take a longer path in air where there is less resistance and it can move faster. Thus, Fermat's principle is that light will always travel by the quickest path, irrespective of the obstacles placed in its way.

With the discoveries of Fermat and Faraday, the stage was set for the entrance of James Clerk Maxwell (1831-1879), whose role was to unify the concepts of electricity and magnetism, and to demonstrate that light is but another form of electromagnetic energy.

In 1864, Maxwell concluded that the role of visible light in the full range of these forces is slight. What we perceive as light is only the narrow center of a spectrum that ranges from tiny x-rays and ultraviolet waves at one end to infrared and miles-long radio waves at the other.

An electromagnetic wave is a combination of coupled electric and magnetic fields in which the vector of the electric field varies along one plane, and the magnetic vector varies along a perpendicular plane. Thus, we can imagine that all electromagnetic waves, including light, move in a particular direction of travel, and that they wiggle from side to side at the same time as they squiggle up and down. These waves that are perpendicular to the direction of travel are called transverse waves. (Figure 2)

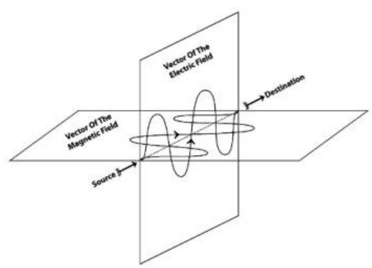

Figure 2

Wave or Particle?

Isaac Newton believed that light was a straight-line stream of corpuscles, much like bullets being continually fired from the muzzle of a machine gun, which bounce off the target back into our eyes, providing both visibility of objects and the sharpness of the shadows they cast.

Experiments soon established, however, that light appears to be transmitted by a wave action, much like the wave motion in water. Measurements established that the wave length of light, the distance between its successive crests, was only about 1/20,000 of an inch. Because of this tiny wave length, we perceive waves of light as a continual beam that travels in a straight line and casts sharp shadows.

The wave nature of light was further established by observations of the frequency, or the number, of wave crests that pass a certain point in a given period of time. Within the spectrum visible to the eye, light has a frequency of about 500 trillion crests per second. From this, and other observations, it became possible to determine the speed of light by multiplying the frequency of light times its wave length.

By the end of the Nineteenth Century it had been firmly established that light travels at approximately 186,000 miles, or 300,000 kilometers, per second, but how and why it was so limited were open questions.

The Shifting Colors of Starlight

Using glass prisms he placed in the direct rays of the sun, Newton was able to demonstrate that what we perceive as white light was actually composed of the range of colors we see in a rainbow. He concluded the separation of colors was a result of their differing wave lengths being refracted through the prism.

When I was in elementary school, one of my teachers explained that the basic color of light was white, a combination of all the other colors that make up the full spectrum. Later, at home on the farm where I lived, I decided to test the theory.

I went out the shop room in the barn where paint was stored and poured together a sample of every color on the shelf. I ended up with a mixture nearer dark grey or black, rather than white, which was stealthily dumped in a hole quickly dug in the soft red soil, a minor toxic dump and a lesson learned.

When my interest in physics was reawakened as an adult, I became fascinated with the colors of rainbows and the light of the sun. In the summer of 1978, I made a series of Super 8mm movies featuring the sun, which I called a "day star," and studied the visual effect resulting from refraction of its light by the camera lens into shifting shafts of vivid colors. I was rewarded with some beautiful film and a loss of the central vision in my right eye.

I also noticed that the edge of a beveled mirror would shatter parallel black lines on white paper into the constituent colors of the light spectrum, and I again wondered if all colors were in fact a part of black, rather than white. (Figure 3)

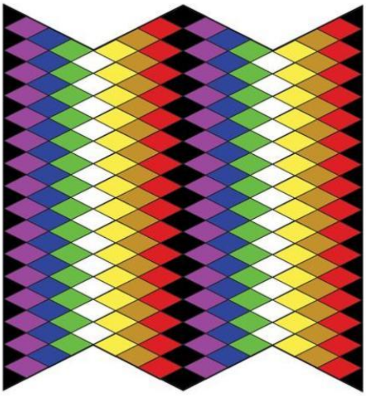

Figure 3

It appears that violet comes out of black, followed by blue and green, and that these three colors are then separated by white from the following yellow, gold, and red colors, before disappearing again into blackness. Thus, it seems there are eight basic colors, black, violet, blue, green, white, yellow, gold, and red, and that each flows from or blends into its neighbors.

Early experiments in the Age of Discovery determined that a black surface was both the best emitter of electromagnetic radiation at elevated temperatures, and also the best absorber of radiation. This is why we wear white clothing in the summer to reflect heat and dark clothing in the winter to absorb it. Although the subject of black-body radiation will be discussed below, the point here is that it is black that absorbs and emits all other colors, not white.

We are all familiar with the fact that fire trucks have sirens to alert drivers of other vehicles to their approach in their race against the flames. If the fire truck is stationary, we will hear the tone of the siren to be steady, and we can understand that the lengths of the sound waves are constant.

If the fire truck is coming toward us, we will hear a rise in pitch, because the velocity of the truck in our direction will cause the sound waves to be slightly shorter. As the fire truck passes by and travels on down the street, we will hear a lowering of the pitch as the sound waves are stretched out. With experience, most drivers can quickly tell whether the siren they hear is approaching, or if the sound is diminishing in pitch.

This phenomenon was discovered by Christian Johann Doppler (1803-1853), who tested it by placing an orchestra on a moving railroad car. Doppler related the effect only to sound waves; however, he suggested that the same might be true of light waves.

Although Newton first explained, physically, how light is split into the colors of its spectrum by passing it through a prism, others combined the prism with a telescope to observe that divisions within the colors were marked by discrete, bright narrow lines. It was determined that the location of these lines within the spectrum was characteristic of the particular atomic element that radiated the light.

Different elements were first studied to determine their unique "fingerprints," and these standards were then used in conjunction with "spectroscopes" and cameras to characterize the light from the sun, different stars, and finally galaxies. From these studies it became possible to determine the chemical composition of all of these stellar objects and, later, the molecular clouds from which they are born.

Realizing that the Doppler effect applied to the wave motion of light as well as to sound, William Huggins (1824-1910) discovered that the spectrum of light emitted by certain stars was shifted.

In 1929, Edwin P. Hubble (1889-1953) used the Doppler effect to determine that the light spectra from all other galaxies (except Andromeda) were shifted to the red end of the spectrum, and were, therefore, moving away from the Milky Way. Moreover, he determined that the speed of their recession is proportional to their distance; that is, those that are the most distant are moving away at the greatest speed.

Additional spectroscopic studies were able to determine the types of complex molecules that occur in the molecular clouds of dust and gas that lie between the stars and galaxies. In these studies, the clouds are seen to absorb light and to reflect their chemical composition by dark lines in the spectrum, while the direct light radiated by the sun and other stars announce their elements by bright lines.

Neither Waves, Nor Particles of Light, But Quanta of Energy

In 1887, Max Planck (1858-1947) became a professor of theoretical physics at the University of Berlin. Among the problems he considered was one indirectly related to the photoelectric effect. He questioned how radiant energy was emitted by electromagnetic waves, including those of visible light.

Planck used a "black-body" radiator, with black interior walls and a tiny pinhole through which genuinely pure light of all visible wavelengths could be observed being emitted when the radiator was heated to incandescence. He also used a bolometer that relied upon the electrical measurements of tiny quantities of heat generated in a blackened platinum wire. The bolometer could detect temperature changes as small as one-millionth of a degree under the impact of specific wavelengths.

If various objects are heated to differing temperatures, a variety of light "colors" are emitted. As an iron bar is heated, we can see that it first glows red, before turning bright orange and yellow on its way to melting. In an incandescent light bulb, we are able to observe that a tungsten wire in a vacuum can be heated to a white-hot temperature without melting, unless we shake or drop the lamp.

In these experiments, external energy in the form of heat or electricity is applied to increase the molecular motion of a substance. This motion, or kinetic energy, in turn, results in an increase in the frequency by which the electrical charges of the molecules oscillate (wiggles and squiggles), giving rise to the radiation of electromagnetic energy, or light.

By use of the bolometer and black box radiators, scientists were able to analyze the total motion of atoms as the sum of individual oscillators at their unique frequencies, and how they shared the total thermal energy at a particular temperature. However, in calculating the results, scientists found that the theory broke down at shorter wavelengths in the ultraviolet part of the spectrum, causing a result considered catastrophic to the theory and contrary to the laws relating to the conservation of energy.

On December 14, 1900, Planck reported a theory to the German Physical Society that reconciled the problems. He stated that energy was not emitted in a continuous flow, as it appeared, but as discrete bursts of energy he characterized as *quanta* (Latin: how much?). The size of the *quantum* (singular) was related to the frequency of its associated electromagnetic wave. For example, since violet light has a frequency twice that red light, its quanta are also twice that of red light.

The formula that relates quanta to frequency relies upon an infinitesimal number, 6.6256 times 10^{-27} erg sec, or 0.0000000000000000000000000066256. The number was designated by *h*, and became known as Planck's Constant.[4]

In essence, in seeking to reduce anything down to "nothing," or a singularity, all equations eventually reach "Planck's Wall," at which point the accuracies of mathematical predictions rapidly diminish.

Ether or Not?

It was early assumed that, since light appears to travel in a wave motion, there must be some special medium within which it travels, just as water is necessary for water waves and a gaseous atmosphere in necessary for sound waves.

Initially, it was believed that all of space was filled by a "luminiferous" ether. However, Maxwell was able to demonstrate that if an ether existed, it had to be the same for all electromagnetic waves in addition to light.

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[4] An erg is a tiny measure of energy. 13,558,200 ergs are required to lift one pound of anything one foot in elevation, and an erg sec is a unit of action derived by dividing an erg by a second.

The demonstration raised several questions: What happens when the earth moves through the ether? Does the movement of the earth disturb the ether, or does it drag the ether along in its wake? The ether was considered to be without mass and was not believed to offer any resistance to the passage of objects. Otherwise, it would, over time, slow everything down to a halt.

Because light moves in transverse waves, the ether was also believed to possess a high degree of stiffness in the sense of plasticity, since waves move more swiftly through stiff media than soft, and electromagnetic waves were quicker, by almost a million times, than other forms of waves.

Initial experiments were inconclusive but, commencing in about 1881, Albert Abraham Michelson (1852-1931) constructed a series of sensitive tests to see if the ether had any effect on the passage of light.

If we imagine the motion of the earth through the ether as a boat and the drift of the ether as a cross, head, or following current, we can see that during its orbit of the sun (which is also moving around the galaxy), the earth will sometimes be going upstream, sometimes downstream, and sometimes cross-stream.

Michelson's experiment involved the use of mirrors to simultaneously promulgate light from the same source in perpendicular directions and to time its return during various parts of the earth's orbit. Numerous experiments found there to be no difference in the time it took light to make the round trips.

Subsequent experiments designed to determine if massive objects produced a drag on the ether also failed to detect a measurable ether. Armand Fizeau (1819-1896) was able to detect a slight drag on the velocity of light in moving water, but the drag did not measure up to either the sum or difference in the velocities of the water and light.

This is where the matter stands today. While we can imagine that there should be a stiff, plastic-like medium for the transmission of electromagnetic waves, including light, no such medium has ever been identified.

Faster Than a Speeding Bullet, or Just Slower Than Infinity?

Even before Newton published his theories on the nature of the universe, the speed of light was established in 1675 by Ole Christensen Rømer (1644-1710).

Galileo had earlier identified the moons of Jupiter and calculated the periods of their revolutions, and Rømer noticed that the moons are regularly eclipsed as they revolve around Jupiter. He was able to determine that the eclipses occurred slightly ahead or behind schedule, depending upon how close Earth was to Jupiter. From these differences, Rømer was able to calculate the speed of light as approximately 186,000 miles per second.

Two hundred years later, James Maxwell proved that light was just the visible portion of electromagnetic waves, and, from this understanding, the speed of electromagnetic waves could be determined by multiplying the frequency of the wave times its wave length. However, all of this only concerned the speed of light in one direction.

Considering the Newtonian system, Maxwell and others questioned whether there could be any variation in the speed of light (slower or faster) depending on the frames of reference for the observer and the source of light.

Maxwell's equations, which identified light as an electromagnetic wave, were not dependent on the velocity of either the observer or the source (whether they were moving toward or away from each other).

In the Newtonian system, an observer moving toward a light source at a certain velocity should perceive the speed of light coming from the source as greater than the standard, and conversely, if moving away from the source, the speed should be less. However, experiments could not confirm this addition or subtraction in the speed of light.

Two researchers, Hendrik Antoon Lorentz (1853-1928) and George Francis FitzGerald (1851-1901), independently concluded that the motion of the earth itself caused the measuring instruments to contract in the direction of its movement, thus defying any measurement of the difference. Henri Poincaré (1854-1912), concluded that the velocity of light was absolute.

Here matters rested until the turn of the century when a young patent examiner in Switzerland also considered these problems during his spare time as he bounced his son on his knee.

THE ERA OF EINSTEIN

With his publication of *Philosophiae Naturalis Principia Mathematica* in 1687, Isaac Newton established the framework upon which the modern sciences of physics and astronomy were built. He believed that the universe existed with clockwork precision within an empty, infinite, and homogeneous three-dimensional Euclidean space.

For more than two hundred years, Newton's description of the universe stood as the standard of comparison for all other discoveries regarding the nature and movement of mass and light.

Newton believed that space was absolute and that, within it, all motions could be compared. He assumed that time was also absolute and mathematically true, flowing by its own nature without reference to anything external.

These two premises seemed to place light—and its velocity—in its own category, without reference to the observations of the mechanics of the universe being made during the last decades of the Nineteenth Century, as the methods of measurement became more exact.

Thus, the stage was set for the introduction of a new actor in the unfolding scientific drama.

In 1905, there resided in Switzerland a young man by the name of Albert Einstein (1879-1955), who had been interested in the nature of light and its relation to time since he was a teenager.

Following an undistinguished university education, Einstein was unable to qualify for a teaching position and was quite happy to secure a position as a Swiss government patent examiner. A fringe benefit of the job was that it constantly exposed him to new ideas and gave him the opportunity and leisure to read and reflect upon the scientific literature of the time.

One of the questions Einstein considered was why very small particles suspended in a liquid seemed to move about with random motion, or Brownian movement as it was called. He wrote a small paper in which he proved mathematically that the small particles were reacting to the constant movement of the liquid molecules in which the particles were suspended. Most simply put, his paper provided a convincing proof of the presence of atomic molecules themselves, the existence of which had not been firmly established by scientific methods.

The same year, Einstein considered the photoelectric effect, which had been earlier noticed and reported in 1886 by Heinrich Hertz (1857-1894). In attempting to verify Maxwell's theory of electromagnetic radiation, Hertz had observed that an electric current could be made to flow between two separated objects in a vacuum simply by shining a light on one of the objects.

Various experiments had shown that the current seemed to consist of tiny bits of negatively charged matter, later shown to be electrons and referred to as photoelectrons in describing the photoelectric effect.

Einstein relied on the emerging theory of quantum energy in proposing that the electric current was carried in “quanta” of energy (which he called photons) by the “waves” of light.

Since a light wave consists of electric and magnetic vectors which both wiggle and squiggle—and if the photon (which is simply a particle of light) is sufficiently energetic—its collision with an electron in one object can cause the electron to break its chemical bond with one surface and to jump across space to the other. The excess energy imparted to the electron, beyond that needed to break its chemical bond, manifested itself as kinetic energy, or energy of motion, which allowed it to do work upon its arrival at the surface of the receiving object.

Einstein's theory of the photoelectric effect made certain predictions regarding this kinetic energy which were proved true by the experiments of Robert A. Millikan (1868-1953). Later, they both received a Nobel Prize for their work, Einstein for his theory and Millikan for his proof.

Einstein received the prize for this paper, rather than for his more famous theories of special and general relativity, because the photoelectric effect proved to have the greatest practical value in a multitude of devices such as burglar alarms, automatic door openers, and television remote controls, all of which rely on the ability to detect and measure specific frequencies of light and the resulting kinetic energy of the flowing current of photoelectrons.[5]

Thus, the nature of light, that started out under Newton as a particle and was then proved to be a wave, was found by Einstein to be a combination of the two. It looks like a wave, but it acts and works like a particle.

One way to view this effect is to compare it to the standing wave exhibited by an electron in its path around the nucleus of an atom. As the electron circles about its orbit on one plane, it vibrates up and down on a perpendicular plane between the two poles of the nucleus. This standing wave provides a continuous shield or presence at all radial locations surrounding the nucleus, except at the very tip of the poles. Therefore, the vibration of the electron allows it, effectively, to be at all places at all times, although it occupies only a tiny point at any given instance.

In the same manner, the energy of a wave of light is distributed across its spectrum, and becomes instantly concentrated when it arrives at its destination. A “wave” of light “wiggles” and “squiggles” along two perpendicular planes, yet it is entirely connected as a single quantum of energy. Its kinetic energy depends on the amplitude of

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[5] A collection of Einstein's papers can be found in *Einstein's Miraculous Year: Five Papers That Changed The Face Of Physics*. Edited and introduced by John Stachel, with a foreword by Roger Penrose, (Princeton University Press, 1998).

the wave, but irrespective of its frequency or wavelength, the entire wave simultaneously arrives at a pinpoint location, and it is not spread out along its wave front. Or, just as a vibrating electron creates a unified shell around the nucleus, the vibrating light wave creates a unified photon, or point of light, even though the wave it rides on may be spread out for some distance.

The Special Theory of Relativity

In the same year he published papers on Brownian motion and the photoelectric effect, the young Einstein lent his considerable, but yet unrecognized intellect to the question of the speed of light and its relation to time.

As noted above, a number of individuals were considering the paradoxes involved as the velocity of mass approached the speed of light and the impossibility of ever exceeding it. What Einstein did was to winnow away the chaff and to describe simply the unchanging quantities that remained.

Einstein's paper, *On the Electrodynamics of Moving Bodies*, established that all laws of physics are invariant in all inertial reference frames. In other words, no matter where one happened to make observations, whether on a stationary or moving frame of reference (both are "inertial"), the laws of physics hold true. In particular, and independent of the speed of either the source of light or the location where it is detected, the speed of light in empty space is the same everywhere.[6]

Einstein accepted Poincaré's theory that the speed of light is absolute and Lorentz and FitzGerald's theory of length contraction, in determining that, since the presence of the ether cannot be detected by any experimental method, it should no longer be

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[6] Einstein's own attempt to explain relativity for the lay person is contained in *Relativity: The Special and The General Theory*, (Crown Publishers, 1961), and he contributed a foreword for Barnett, Lincoln, *The Universe & Dr. Einstein: The Meaning of Time, Space, and Matter* (William Morrow & Co, 1957).

considered as the medium within which gravity operates or light travels.

In its place, Einstein related the space surrounding mass to time itself in recognizing that the two concepts are not independent, but are necessarily related, or “relatives,” in that the measurement of one can be the measurement of the other.

Einstein showed how time intervals between two events are measured differently in different inertial reference frames. We can imagine two surfers each “hanging ten” on a photonic surfboard and riding light waves that are approaching each other from opposite directions. Each will notice that the time recorded on the wrist watch of the other is running slower than the one on their own wrist.

To the extent that one measures the passage of time as indicative of his or her travel at or near the speed of light, the watch of the other will appear to be moving so slowly as to be stopped. The “relativistic” slowing of clocks is called “time dilation.”

The effect of acceleration on time has been proven by installing atomic clocks on aircraft and by comparing their elapsed time with identical clocks kept in the laboratory. In relation to the clocks left behind, the clocks on airplanes were subjected to acceleration, and were found to have counted off fewer time intervals than those kept in the laboratory.

In the same way, should we ever achieve the ability to travel in space at relativistic speeds, a young woman might take a space trip requiring but a couple of her years and return to find her husband has died of old age, and her children have grown elderly.

Another relativistic observation in moving inertial reference frames is “length contraction,” as proposed by Lorentz and FitzGerald. In the same way that one surfer perceives the watch of the approaching surfer moving slower than his own, each will look down and see their own photonic surfboard to be its normal length, but will perceive the length of the other approaching board in another frame of reference as too short to "hang" one, much less ten toes.

The other board that appears to be in motion in reference to the first surfer's frame of reference undergoes contraction in that dimension which is parallel to the direction of the motion to the point of becoming so infinitely short as to be invisible. Imagine that the first surfer is seeing his own reflection in a thin mirror that is approaching at the speed of light, and that depth is only illusionary.

In addition to the normal three dimensions of height, width, and depth we are accustomed to in everyday life, time then becomes a fourth dimension that relates to space as a negative number in the non-Euclidean geometry used to define it. Thus, time and space are related, but separate, members of the measurable dimension referred to as "space-time."

We can measure the distance between two locations in space, and we can measure the time between two occurrences. In the fourth dimension of space-time, we measure the space-time interval between two events. The space-time interval is invariant and is the same for all inertial frames of reference.

Under Newtonian physics an object could be continually accelerated to increasingly higher velocities over time, but, with the speed limit imposed by Einstein's special theory of relativity, the velocity of light can never be achieved. The reason is that as velocity increases, an ever increasing amount of force is required to move the increasingly "heavy" mass until the point where further increases in force cannot overcome the increasing "weight" of the object. Or, put differently, as the velocity approaches the speed of light, the acceleration decreases until it slows to zero.

Thus, in the same way that the photonic surfboard of the approaching surfer becomes shorter as its transporting wave approaches the speed of light, its mass also increases in proportion to the increase of velocity. It does not become dead in the water (except as viewed by the other surfer), but it can never go faster than the speed of the light wave which transports it.

Regarding the special theory, Einstein commented: "It was formerly believed that if all material things disappeared out of the universe, time and space would be left. According to the relativity theory, however, time and space disappear together with the things."

Seeing what others overlooked, Einstein concluded that mass was simply congealed energy and that all energy was simply liberated matter. Thus, in the photoelectric effect, the photons were quanta of pure energy which had shed their mass when traveling at the speed of light.

Writing in 1907, Einstein used some of his ideas from the photoelectric effect and the mathematics from the special theory to postulate that an object that emits energy in the form of light will have its mass reduced by the amount of energy divided by the speed of light squared.

The initial expression, $M = E/C^2$, can be solved algebraically to become the most famous equation in history, $E = MC^2$. E stands for energy, M for mass, and C (the speed of light) was derived from *celeritas*, the Latin word for speed. The speed of light is approximately 186,274 miles, or 299,779 kilometers, per second.

The General Theory of Relativity

With his publication of the three major papers of 1905 and the others which followed, Einstein not only achieved worldwide fame, but, more practically, was finally awarded a doctorate degree and secured a succession of increasingly prominent teaching positions that allowed him to continue thinking about the problems of relativity.

The special theory was concerned only with the measurements of space and time between observers moving in a straight line at a constant velocity, such as in a railroad car, relative to the ground. Einstein knew he had to solve the more difficult problems concerned with observers who were either accelerating or slowing down, or who were moving on a curve. This, of course, was specifically the question of unifying the problems of gravity with the more limited special theory.

This time, rather than a trip on a railroad car, Einstein relied on a thought experiment involving an elevator ride to the stars. Imagine an elevator shaft extending upward far out into space beyond the influence of Earth's gravity, and imagine that you are being pulled aloft at a speed of 32 feet per second (the speed you would fall at the surface of the earth if you jumped into an empty elevator shaft). You would feel your feet pressed against the floor, as if you were standing on the surface, and if you dropped a coin, it would appear to fall to the floor in a normal manner.

In essence, you could not tell whether you were being accelerated through space at 32 feet per second, or were standing still on the surface of the earth. Thus, there is no difference between gravitational acceleration and other forms of acceleration. In what has come to be referred to as the principle of equivalence, Einstein postulated that a gravitational field exists, relatively, but was not a "force" in the usual sense.

Einstein imagined that if a flashlight was made to shine its rays from one side of the elevator car to the other, and if the elevator car was made to rise at or near the speed of light, the beam of light would appear to be curved downward.

Thus, since the special theory found there to be an equivalence between mass and light (or energy), the "mass" of the light would be "attracted" to the floor in the same manner as would be an individual riding in the elevator car. Einstein theorized that a beam of light, such as that emitted by a distant star and passing near a heavy object such as the sun, would be deflected or bent by the sun.

In 1913, Einstein jointly published an *Outline of a General Theory of Relativity and a Theory of Gravitation* with Marcel Grossmann (1878-1936), who contributed the mathematical portions of the paper. Einstein was dissatisfied with the mathematical implications of the paper, as they appeared to show that there were an infinite number of solutions.

Einstein struggled for two years to find other methods of calculation before returning to non-Euclidean geometry in determining that, instead of an infinite number of solutions, there was but one solution to an infinite number of different frames of reference.

In 1916, Einstein published a collection of ten field equations defining his theory of general relativity, that essentially did away with gravity as a "force." Instead, there was only the geometry of the universe itself that caused the curvature, or space-time continuum, which in turn *appears* to be the attractive force of gravity.

Under the special theory, one might think about a flat surface such as the taut covering of a drum, and imagine a fly crawling across it in one direction. The time dimension represented by uniform acceleration can be imagined as perpendicular to the fly's path.

With the general theory, we have to imagine a less taut covering such as a large sheet of rubber (space-time) onto which is rolled a bowling ball (Earth), that distorts the sheet and which causes a baseball (Moon) also rolled onto the sheet to circle around and move toward the heavier bowling ball. Einstein believed that massive bodies, such as stars and planets, cause such a distortion in the space-time continuum around themselves and results in the "attraction" of other less massive bodies.

Einstein offered several possible methods to prove his theory. One dealt with the precession of the orbit of Mercury which, according to Newtonian physics, appeared to take an extra 43 seconds of arc each year to return to its place along its elliptical orbit around the sun. Einstein's field equations neatly predicted exactly such a difference when applied to the orbit of Mercury.

Another method of proof concerned the amount of deflection of light from a distant star as it passed near the sun, and the only way to test it was to wait for a suitable eclipse of the sun. The effort was delayed (because of World War I being fought between

Germany and England) until May 29, 1919, when an English team led by Sir Arthur Stanley Eddington (1882-1944) made observations that confirmed a deflection almost exactly that predicted by Einstein's field equations.

The Probability of Einstein's Quantum Relatives

While Einstein was working on his general theory of relativity, a young physicist in Denmark, Niels Bohr (1885-1962), was relying on the photoelectric quantum theory of Einstein and Planck to unify its concept with that of a nuclear atom previously described by Ernest Rutherford (1871-1937).

Bohr, who had studied under both Planck and Rutherford, was aware of the belief under classical physics that electrons orbiting the nucleus of atoms would continually radiate away energy until they would spiral into the nucleus. Bohr was also aware that experiments had not confirmed this action—to the contrary, different atoms radiated at specific and characteristic frequencies.

In 1913, Bohr proposed that atoms exist within certain stationary states or levels of organization in which electrons move around the nucleus in restricted orbits during which no radiation is emitted. However, radiation is emitted when the electron jumps from one allowed orbit to one closer to the nucleus, and, when radiation is absorbed by an atom, it causes electrons to jump to an allowed orbit further from the nucleus. In either case, the radiation is absorbed or emitted in discrete units, or quanta as proposed by Planck and Einstein.

Following confirmation of Bohr's theory by spectroscopic examination of the hydrogen atom, Rutherford's view of the atom as a miniature solar system was vindicated, as was Planck's and Einstein's proposition that energy was conveyed in specific chunks or quanta. However, Einstein was never able to come to grips with the uncertainty of quantum mechanics, for he was never able to give up faith in the ultimate ability of physics to recognize causation in predicting actions and reactions in the future.

Einstein did not believe that "God played dice with the universe"; however, for Bohr and others, the mathematical system, which came to be known as quantum mechanics, supplemented and ultimately replaced general relativity as a description of the interactions that take place on the subatomic level.

A more complete definition of quantum mechanics was provided in 1927 by the publication of the "uncertainty principle" by Werner Karl Heisenberg (1901-1976). The principle holds that related pairs of quantities, such as the position and momentum of an electron, cannot be measured simultaneously. Any attempt to measure the one destroys any ability to measure the other.

Differing from the view of classical physics that an electron is a particular particle at a specific location at a given time, the principle of uncertainty tells us that an electron really exists at all places at all times around the nucleus until it collides with something, at which time and everywhere else, it is no longer there.

With the introduction of the uncertainty principle, quantum mechanics became a method of mathematically defining the distribution of subatomic particles, which otherwise exist only as random noise. Thus, the location of any particle can be described, but only by using a system of statistical probabilities.

Quantum mechanics are considered to be of equal value to general relativity in making physical descriptions, and it has satisfied every experiment devised to test its reliability, particularly those conducted in particle accelerators having the ability to break down particles into their constituent parts.

Quantum mechanics seem to tell us that the subatomic manifestations of our universe do not really exist until we perceive and define them—until we give them a name.

To date, physicists have been unable to reconcile quantum mechanics with general relativity. Relativity provides a means of defining the beginning of the universe as a singularity existing at a particular moment, while quantum theory holds that it is impossible to define the location, size or velocity of anything, including a singularity, at any particular moment.

Einstein was never able to reconcile himself to the “spooky” processes of quantum theory, and as he lay dying in his bed in the Princeton University Hospital in April 1955, he spent his final hours of life scribbling equations in his search for the truth of our physical existence. Today, most physicists no longer worry about the meaning of quantum mechanics, they just accept that it works.

Entropy and Omega One

The year following his publication of the general theory of relativity, Einstein published another paper in which he extended the general theory to include a description of the universe from its beginning to its end. In his paper of 1917, Einstein showed how the field equations of the general theory could be used to describe the movement of massive bodies over long periods of time.

The only problem was the equations showed the universe was unstable, and it was probably expanding. This, Einstein could not accept because he believed the universe has to be stable and unchanging, the same everywhere in every direction.

Einstein then committed what he later described as one of his greatest mistakes. He added a “slight modification” known as the “cosmological constant” or “Delta Term,” which was necessary to make “possible a quasi-static distribution of matter as required by the fact of the small velocities of the stars.”

Scientists remain undecided whether the cosmological constant was a mistake; however, the latest evidence seems to indicate that Einstein was not originally in error since the universe seems to be expanding at a rate that exceeds calculations. This negative gravitational force may represent more than half the energy in the universe, a form of antigravity that correlates closely with the Delta Term.

Several years later, in 1922, Alexander Friedman (1888-1925) worked out Einstein's equations without the cosmological constant.

Leaving out the Delta Term, he found there to be two possibilities inherent in an expanding universe. In the first, the expanding universe does not possess enough density of matter and will, therefore, expand forever. The second possibility assumes the density of matter is sufficient to allow the action of gravity to slow and ultimately stop the expansion.

Shortly thereafter, Edwin Hubble used the large telescope at Mount Wilson in California to measure spectrographically the red shifts of distant galaxies to determine that all observed galaxies were moving apart at a rate that is proportional to their distance from the Milky Way. In other words, the most-distant galaxies are moving away at the greatest speed. Hubble's findings provided the necessary proof that the universe is indeed expanding and provided the law that tells us the rate at which it is being inflated.

The word entropy has several dictionary meanings. Coined in 1850 by Rudolph Clausius (1822-1888), *entropy* was first used to describe the residue of energy that remains inaccessible in a closed thermodynamic system. Clausius concluded that entropy is always increasing in the universe, somehow drained like a fluid into an imaginary lake of equality in which it is no longer available.

In astrophysics and cosmology, entropy has come to describe the nature of our perceived universe in response to emerging evidence of an exploding cosmic egg some 12 to 13½ billion years ago. Scientists who accept the "big-bang" theory of creation are further divided into two schools of thought.

Those who speak of "open entropy" imagine the universe in another half-trillion years or so as a cold, scattered collection of lifeless particles floating forever in the vastness of space. All energy will have been exchanged, and all mass will have achieved escape velocity from the gravitational center of the universe. Our perceived universe would be left dead, unburied, and unnoticed.

A more optimistic view of the future is held by those who believe that there is sufficient unidentified and unmeasured matter in the universe ultimately to attract all mass back to a "big crunch" in the center that will again explode outward in a continuing saga of death and rebirth.

If we view our universe as a "closed entropy" system, we see all essential mass, including Earth and its inhabitants, as ultimately returning to its starting point after a long convoluted spiral through the empty heavens.

Today, it is generally understood that the universe is the same in every direction and that it is expanding in a cosmologically constant manner. In addition, scientists use the term "Omega" to refer to the amount of matter required in the universe to bring expansion to a halt and to cause its collapse.

If Omega is greater than one, there will be enough matter to cause the collapse of the universe. If Omega is less than one there will be insufficient matter and the universe will continue to expand until it meets its heat death.

Relying upon a growing database of supernovas, measured at varying distances from Earth and comparing the distances with their red shifts, a majority of scientists now believe expansion will continue forever. Most interesting are recent findings that the speed by which the universe is expanding is accelerating, as energy continues to mysteriously pop into the universe.

One explanation may be found in Einstein's greatest blunder, his Delta Term, that provides an antigravity force resisting the pull of gravity. This remains as one of the greatest mysteries in astronomy.

If we close our eyes and try to imagine a universe in which every observable thing is increasingly moving away from us, we will find that ultimately there will be nothing left to see. Everything else will have accelerated beyond the speed of light and moved beyond the ability its light to return to us.[7]

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[7] Greene, Brian, "Darkness on the Edge of the Universe," *New York Times*, January 15, 2011; Seife, Charles, *Alpha & Omega: The Search for the Beginning and End of the Universe,* (Viking, 2003), pp. 58-62.

If we give free rein to our imagination we can see two alternatives. One is that everything continues to be pushed apart in straight lines away from everything else, forever. Or, as we have learned, all straight lines ultimately curve in space, either in relation to things we can see or to things we cannot see. Thus, it seems more logical that, ultimately, everything will come back together—at or beyond the speed of light. It is certainly a less boring outcome to contemplate.

Black Holes in Space-Time, the Eternal Game of Marbles

Just as general relativity postulates there are conditions in which the entire universe possesses sufficient mass to curve space back upon itself, it also provides that anytime there exists sufficiently concentrated mass at any point, a "black hole" may be created which is so powerful, gravitationally, that nothing, not even light, can achieve escape velocity.

It is not the amount of mass that is involved, but rather the density of the mass that determines whether space time can be folded up in such a manner as to deny even light an exit. There are two ways of seeing it. In one, "gravity" is so powerful it completely bends the light wave back upon itself. In the other, the gravitational red shift is so extreme the "frequency" of the light wave is reduced to zero, and thus ceases to exist.

The theory allows for black holes of any size, and it has been predicted that, much like neutrinos, tiny black holes may be zinging around and through us at any given time. Or, more likely, all galaxies are centered upon black holes, and many larger stars end their lives in "neutronic" singularity.

Ultimately, all mass in our universe may come to be contained in a single black hole, or singularity. The likelihood our entire universe had its beginning, experiences its present existence, and will come to its ultimate "end" within such a black hole was proposed and mathematically proved by Stephen Hawkins (1942) and Roger Penrose (1931) during the Sixties.[8]

So, one way or another and sooner or later, the marbles may, in the end, all roll back together into a singularity of pure energy, and the birth and processing of mass will continue, relatively speaking, forever. But, within any particular quanta of energy, the manner, means, and movement of mass are, forever, a matter of chaos.

[8] Hawking, Stephen, *The Universe in a Nutshell*, (Bantam Books, 2001), p. 41. Undoubtedly the best (and most beautiful) book for lay people to understand relativity.

PHYSICS FOR THE NEW MILLENNIUM

The Force Is the Field

Newtonian physics allowed a fairly simple understanding of the concepts of force and field in that the electromagnetic “force” could be easily demonstrated by such means as sprinkling iron filings on a sheet of paper covering a magnet or by using a magnet to push aside a wire carrying an electric current.

Thus, the Newtonian understanding of gravity was that mass produced a force within its surrounding field, that was always there whether or not another body of mass was present to be “attracted.” It was the gravitational potential that manifested itself as a force.

With his general theory of relativity, Einstein eliminated gravity as a “force” by which mass “attracts” other matter. Rather, matter, depending upon its mass, distorts the fabric of space-time surrounding itself, forcing other mass, including light, to take alternative geodesic paths.

Therefore, while we can actually “hear” how the gaseous atmosphere acts as a field or medium within which sound waves travel, the elimination of gravity as a force and the ether as a field leaves us with a concept of space that is purely theoretical. Space-time is not a separate entity within which mass can be found; it is a part and parcel of the universe itself.

Mass entering a distortion of space-time around other mass is accelerated due to the curvature of space-time and appears to be responding to a gravitational force. Einstein’s insight was that acceleration was equivalent to gravity.

Einstein also believed that electromagnetic fields should cause space-time to curve in a similar manner, and he unsuccessfully tried to include the electromagnetic forces with the force of gravity into his theory of general relativity to create a "unified-field" theory.

The theory of quantum mechanics, which expanded on general relativity, defines the infinitely-ranged electromagnetic force as an exchange of light quanta or photons between charged particles. Thus, charged particles are enclosed by a cloud of virtual photons (particles of light possessing energy) with zero mass, which they alternatively emit and absorb when approaching other charged particles. The electrical force is the result of this constant interchange of virtual photons between the charged particles.

The nuclear forces have a more limited range and result from a nucleon (a proton or neutron, usually within an atomic nucleus) emitting and absorbing virtual quanta, with mass, from a cloud of virtual quanta within which it is enclosed. When two nucleons approach each other, the particles emitted by one are absorbed by the other resulting in an attractive force between them.

It is believed that all basic forces, including gravity, may be described by quantum theory. Because the gravitational force has an infinite range, like the electromagnetic force, its exchange quantum (usually referred to as a graviton) must also have zero mass, and because its force is so weak, it must carry a very tiny amount of energy.

Gravity waves have never been directly detected; however, their existence has been established, relativistically, by studies of the orbital period of a binary pulsar, and they are generally believed to exist.[9]

If then gravity exists as a "force," what is the field within which it acts, and what similarity does it share with that of the electromagnetic and nuclear forces? As seen earlier, experiments performed to identify the presence of an ether separate from and within which the mass of the universe moves have been unsuccessful.

Earth's thick gaseous atmosphere contains 10^{25} molecules per cubic meter; however, outer space, particularly between galaxy

[9] Will, Clifford M., *Was Einstein Right?,* (Basic Books, Inc., 1986).

clusters, is an almost perfect vacuum containing as little as one hydrogen atom per cubic meter and a temperature of -454º Fahrenheit.

We have been taught that a photon can travel for billions of light years through space without encountering anything; however, this view of a cold and empty void is now being challenged by studies which have demonstrated that most of the mass is not visible.

All "light" matter, including everything we can see or readily detect, from the infrared through visible to radio waves, including protons, neutrons, and electrons probably constitutes less than five percent of the whole. The remaining 95 percent consists of strange dark stuff, including matter and energy.

We cannot "see" the dark stuff, but because of the manner in which galaxies and superclusters of galaxies rotate, it has been determined that they are locked together by some ten to 100 times as much dark matter and energy as we can see.

Edwin Hubble's discovery in 1929 that the universe was expanding created the expectation that, at some point, expansion would slow and contraction would commence; however, recent observations by the space telescope named for him, disclose that the universe is in fact expanding, but at an *accelerating* rate.

Several theories have been advanced to explain the accelerating expansion of the universe, including Einstein's "cosmological constant," all of which center around a "dark energy" associated with "dark matter."

The cosmological constant, or Delta Term, predicts that energy is a property of empty space which remains "constant," as the "space" expands with the universe. This ever-increasing energy causes acceleration.

Other scientists believe quantum mechanics allow for empty space to bubble with the appearance and disappearance of virtual particles; however, thus far all calculations have been way off the mark as to how much dark energy would be produced.

Or, Einstein's theory of gravitation may simply be wrong. At this point, no one knows.

Some dark matter, including massive black holes, neutron stars, and brown dwarfs can be detected by their gravitational effects on the passing light from distant sources; however, weakly interacting massive particles, known as WIMPs, pass through ordinary matter without any interaction. These include *axions* and *neutrinos*.

Axions are believed to been produced during the "big bang" and have very little mass. Scientists have proposed the existence of axions to round out equations involving neutrons and the search for them continues.

Neutrinos are the stardust of creation. One result of beta decay in the breakdown of a neutron into a proton is the spinoff of a photon-like particle which instantly breaks down into a negatively-charged electron and a neutrino.

The neutrino, which has no electrical charge, carries off the extra, or rebound momentum from the splitting of the neutron. The amount of rest mass possessed by the neutrino remains an open question; however, it does possess a quantum spin, which is conserved in its interaction with the rare particle it occasionally encounters.

Neutrinos are also produced in a supernova when they cart off the excess energy produced in the core of the collapsing star as it is torn apart by the resulting shock wave. More routinely, neutrinos constitute about one-tenth of the energy radiated by stars, including the sun.

All together, trillions of neutrinos pass unnoticed through our bodies every minute. Since they are so tiny and move so fast they rarely intersect or interact with other matter. If they have zero mass, they move at the speed of light; however, to the extent they have some mass, their speed is slightly slowed.

One estimate is that neutrinos have a mass equal to about 7.5 electronvolts (eV). In comparison, the tiny electron has 500,000 eV, or put differently, the mass of a neutrino may be only about 0.0014 per cent of that of an electron.

An experiment conducted by a consortium of universities using a detector located in an old zinc mine 3,250 feet under the surface in the Japanese Alps determined that there was a difference in neutrinos that traveled through the earth before being detected and those that came from overhead.

The difference was in the oscillation of those passing through the earth, which could only occur if the neutrinos possessed mass. As a result of this oscillation, any given neutrino can possess differing masses at different times as it transforms itself from one type of neutrino to another.[10]

Physicists from the European Organization for Nuclear Research in Geneva (CERN) recently reported they had confirmed the transformation of neutrinos. The finding provides evidence "that certain subatomic particles have mass and that they could account for a large proportion of the so-called dark matter . . ."[11]

With the difference between the two types of neutrinos representing the minimum mass of a neutrino, it has now been further estimated that the neutrino possesses about one ten-millionth of the mass of an electron. However, since there may be 50 billion neutrinos in the universe for every electron, there is more total mass represented by neutrinos than electrons, and perhaps more than in all other forms of matter.

Although light itself has no mass, we have seen that it is subject to the curvature of space caused by the presence of mass; thus, neutrinos must also be affected by gravity. The question arises whether a neutrino has an effect on gravity—does it distort the space-time around it as it passes through?

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[10] Maugh, Thomas H., II., "World of Physics Jolted by Finding on Neutrinos," *Los Angeles Times*, June 5, 1998, pp. A1/22; Seife, Charles, op. cit., pp. 143-145.

[11] ---, "Physicists unlock mystery of subatomic particle," *Los Angeles Times*, June 1, 2010.

If it is true that neutrinos possess mass and their task is to carry momentum and quantum spin away from gravitational events, then they must be a part and parcel of mass and thus a reflection of the action of gravity at a distance.

More specifically, given the fact that neutrinos permeate all of space, does their dense presence, along with other "dark matter," contribute to a medium or field through which the waves of gravity move toward the shores of mass?

The question remains unanswered. Currently, it appears that neutrinos, because of their tiny mass, represent only a small fraction of the dark matter of the universe. The balance remains unknown; however, what is clear is that the neutrinos are the link between what is known and what remains to be discovered.

Most recently, physicists have proposed that every particle has an undiscovered twin *super partner* having properties different from the known particle. Known as *supersymmetry*, the theory proposes the existence of *sparticles* called selectrons, squarks, sneutrinos, photinos, gluinos, winos, and zinos.

These sparticles may possess far greater mass than their known twin particles and may contribute to the cold dark matter that helps hold the universe together.[12]

Supersymmetry theory also proposes the existence of *neutralinos*, 30 to 5,000 times smaller than a proton, which may have also been produced in abundance during the "big bang."

Scientists continue to search for all of these elusive particles in hope that discovery of their number, weight, and properties will answer the questions about the elusive dark matter and energy.

There is experimental evidence that the force and energy of these particles can be measured and that they must be taken into effect when calculating any interactions. There is speculation that this

[12] Seife, op. cit., pp. 150-161.

force, known as *zero-point energy* contributes to Einstein's Delta Factor which is forcing the universe apart.[13]

Thus, the traditional vision of a cold, dark, absolute vacuum containing the visible mass of the universe has been replaced by the image of a seething pot, filled with dark particles and energy popping in and out of existence.

Or, imagine that a super-sensitive detector, having the ability to display the passage of every single passing particle and manifestation of mass and energy, would demonstrate that "empty space" is filled with mass and energy at all places and at all times, even though they rarely, if ever, interact with each other.

More generally, does the combination of neutrinos, alpha, beta, gamma rays and all other subatomic particles and sparticles, light and dark, known and unknown, sufficiently occupy and transiently distort all space-time within the universe as to provide the plastic structure required for the transmission of light and the particles themselves? Thus, does the "force" become its own "field?"

The Field of Mind—the Medium of Time

Einstein made a great leap of imagination from the principle of equivalence between acceleration and gravity to form a conclusion that it was space itself that became curved in the presence of mass. In doing so, he relied on non-Euclidean geometry in which the total of angles within a triangle on the surface of a sphere can exceed the limit of 180 degrees set by Euclid. Indeed, we can construct a triangle on the surface of a sphere that has three right angles, for a total of 270 degrees.

As difficult as it is to imagine a curved three-dimensional space, the inclusion of the time dimension in a four-dimensional definition of reality—in which time is equivalent to space—stretches our imagination to its perceptual limits. However, imagine it we must if we are to understand, even remotely, the reasoning of the special and

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[13] ---, op. cit., pp. 182-189.

general theories of relativity and to follow the subsequent refinements offered by quantum mechanics and the principles of uncertainty and chaos theory.[14]

The evolution of physics from Newtonian mechanics, in which time could be measured at every location by a single clock, through Einstein's theories of special and general relativity, has now provided us with a variety of mathematical solutions that allow for time travel.

If we imagine children riding on a carousel whose outer edge spins at the speed of light, time would slow for the riders and would appear to speed up for their watching parents. When the carousel stopped, the children would depart into a future well beyond the length of their short ride.

In 1949, Kurt Gödel (1906-1978) provided a relativistic solution in which the entire universe rotated and in which a traveler could accelerate around the universe to return at the moment of departure.

In 1974, Frank Tipler (1947) relied on a solution that incorporated an infinitely long, dense, rapidly spinning cylinder whose surface moved at a quarter of the speed of light to produce layers of negative and positive space time around it allowing a spaceship to travel through the negative area and return before it left.

In 1988, Kip Thorn (1940) proposed the construction of a time gate consisting of two large conductive plates initially separated by the distance of a single atom acting as the mouth to a wormhole. Unfortunately, the plates would have to be as large as Earth's orbit.

All of this suggests a question, which, for now, can only be asked and not answered: Has the "collective consciousness" of humanity arrived at a plane where our common mind becomes capable of logically understanding the external forces which act upon our perceived universe in the absence of experimental evidence of their existence?

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[14] The ramifications of chaos theory go beyond the limits of this effort; however, the interested reader would do well to begin with James Gleick's *Chaos: Making a New Science*, (Penguin, 1987).

In other words, if we are ever to go to any place truly significant within this universe and its adjacent dimensions, or in time, or to more fully understand the mechanics by which it operates, must we acknowledge that no longer can any one individual contain within her or his own mind all that must be known and understood to do so?

Finally, is the "Mind Field" the medium within which the forces of collective consciousness will act in the future to propel our children through time and beyond the universe and its associated dimensions? Can the "Mind Field" reflect or transmit the beacon required to safely guide them on their homeward journey?

From the moment we struck the first flint and created language to teach the making of fire and tools, our species has been defined by our ability to mentally synapse beyond the limitations of instinct, to acquire and expand knowledge, and to teach the tools of learning and the value of exploration to each new generation.

We now stand at the edge of the mind field of time, and we are just beginning to surf the waves of information along the seashores of space and to cast our net upon the wisdom of eternity. To sail onward, we must accept that our minds have become intertwined, and that unity of mind must be the universal trait which binds us to all other sentient beings, everywhere.

We are Mindkind on Earth, and our children will learn to fly through time and into adjacent dimensions.

The Arrow of Fate Aimed at the Bullseye of Time

With the advances of Galileo and others, most thinking individuals surrendered the belief that the earth was the center of the universe; however, it was not until the Twentieth Century that the discovery of galaxies beyond the Milky Way enabled us to comprehend that our galaxy existed in relation to other and greater mass.

As we first learned that the earth is not the center of the universe, next that the sun itself moved in relation to the Milky Way, then that the Milky Way was but one galaxy in a cluster of other galaxies, and finally that our local group of galaxies moves in relation to something greater, we have at each stage of our understanding been forced to accept that there has always been something beyond our limited perception.

Galileo and Newton proved that the natural state of mass is one of constant velocity; therefore, *is it not reasonable to expect that our perceived universe must be in motion relative to some greater mass?*

Indeed, aren't we compelled by logic to conclude that it *must move*?

Several theories are current that support the concept that our universe may exist in connection with something more. The first challenges the idea of a "big bang" by proposing that our universe exists much like a flat sheet on a clothesline which comes into contact with a "big splat" with another flat sheet hanging on an adjacent line. The collision with the neighboring hidden universe produces the energy and mass we see and measure.[15]

Another theory holds that entirely new universes are being produced by the laws of quantum mechanics every moment. One of its most exciting aspects is the idea that our universe is part of an enormous *multiverse* that constantly produces new universes.[16]

If then, our universe exists in relation to greater mass, how can we suggest the greater, or more inclusive, universe mathematically? Einstein's famous equation $E=MC^2$ describes our flat universe. If Omega is less than one, the universe will end up being shaped like a saddle; if it is more than one, the universe will be closed in upon itself as in a hollow sphere; if it is precisely one, it is much like the flat sheet hanging on a clothesline. In either case, at every place we might find ourselves within the universe, we would perceive it as flat.

Another way of viewing our universe is to imagine the effect of squaring anything by multiplying it times itself. For example, if we multiply two blocks times two we end up with four adjoining

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[15] Seife, op. cit., p. 196.

[16] ---, op. cit., p. 221.

blocks in a flat, or two-dimensional surface. If we want to demonstrate three dimensions, we must cube the original block, or multiple it times itself one more time. Thus, two cubed is two times two times two, or eight, and we have raised the two-dimensional object up to three dimensions.

Therefore, in order to imagine a greater universe, we might consider squaring mass and energy and cubing the speed of light, the governor of universal expansion. Since the amount of energy in our flat universe is measured by the multiplication of its mass times the speed of light squared, we can imagine a greater universe defined by squaring mass and energy and cubing the speed of light.

Thus, one way of imaging a greater, or mega-universe is to define it by the equation $ME^2=MM^2C^3$ in which "ME" represents "mega-energy" and "MM" designates "mega-mass."

Once we can imagine our universe surrounded by and a part of a mega-universe, how can we picture the movement of our universe in relation to the other universe? Given all we presently know, the most likely movement would be perpendicular on a curve, but perpendicular to what?

Two scientific endeavors have provided clues to the direction in which we are heading. The first was the launching by the United States of a satellite into Earth orbit in the early 1980's that was equipped with infrared detectors.

Being above the earth's atmosphere, the Infrared Astronomical Satellite (IRAS) was able to see through the dust that infects all galaxies, including the Milky Way. IRAS was able to survey the distribution of galaxies far deeper into the universe than had ever been achieved with optical telescopes on Earth.

Among the most interesting findings by IRAS was that our Local Group of galaxies is moving toward a concentration of galaxies, or "great attractor" in a particular direction of the sky at about 600 kilometers per second relative to the expansion of the universe.

The finding of IRAS was later supported by the results of the Cosmic Background Explorer (COBE) experiment in 1992 that confirmed the uniformity of the background radiation of the universe and proved that up to 99 percent of the mass in the universe is in the form of unseen "dark matter." The cosmic background radiation manifests itself in the residual radio waves we hear as static on our radios or see as "snow" on our television screens.

The COBE satellite was able to detect temperature fluctuations of 30 millionth of a degree, and to identify the heat of the underlying dark matter that provides the "gravitational" attraction causing our Local Group to "stream" toward a particular concentration of galaxies, without reference to the measurable expansion of space-time.

Since there are no "ups" or "downs" in our universe, and there is no center, the direction in which we appear to be heading within our universe toward the "great attractor" may presently provide the only line from which we can construct a perpendicular in order to imagine a relationship with anything outside our universe.

The Limits of Infinity

In December 1997, Austrian experimenters were able to successfully replicate the polarization of a photon at a distance of three feet. In 2004, the experimenters carried out a successful teleportation with particles of light more than 600 meters across the River Danube.[17]

These primitive first steps in teleportation through the use of quantum mechanics point the way toward the day when we may be able to step aside from the four dimensions of our perceived

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[17] Ricon, Paul, *Teleportation goes long distance*, BBC News, August 18, 2004; http://newsvote.bbc.co.uk/mpapps/pagetools/print/news.bbc.co.uk/2/hi/science/nature/3576594.stm.

universe and to travel in time and hyper-space and to reappear accurately in the here and now after our voyage.

As long as we fail to conceive of space and time travel beyond the speed of light, we will be forever limited in our ability to travel to any place significant within our universe. For example, assuming we achieve space travel at the speed of light and can travel 5.88 trillion miles each year, it would still take us 100,000 years to just travel across our own Milky Way galaxy. If we wanted to go to the nearest galaxy, Andromeda, it would take us two million years.

Ultimately, we must accept that there are dimensions which exist outside of and beyond our present comprehension. Moreover, we must accept that, while the speed of light operates as a governor within this universe, there may be another aspect of light speed operating upon and within the mega-universe outside or alongside of the dimensions we live within.

We must search for the means to step aside or spin away from our universe into the jet stream of another speed of light and then reappear within this universe where we want to be. The trip could be from Los Angeles to New York, from Earth to Mars, or from the Milky Way to other galaxies.

To imagine such a journey, we must continue to stretch our imagination and picture that our mega-universe must itself move in relationship to yet another universe. Just as the arm swings down from the shoulder, and the wrist rotates from side to side, so too does the elbow flex independently from the other two.[18]

It must be as Galileo said, "*Eppur si muove*." Given all that we know, there can be no other logical conclusion.

To again expand upon Einstein's formula for describing our perceivable universe to include both a mega-universe and yet another "eternal" universe, we might imagine that to describe

[18] To correlate the concepts of eternity and infinity, I sometimes imagine that eternity is the silver on the backside of the mirror of infinity.

these further limits we could cube both energy and mass and raise the speed of light to the fourth power ($EE^3=EM^3C^4$).

It is here we must pause, collect our thoughts, and construct models within which to contain these imaginary moving universes. Figure 4 represents such a leap of faith, and the discussion of geometry that follows is an attempt to construct a simple springboard for the jump.

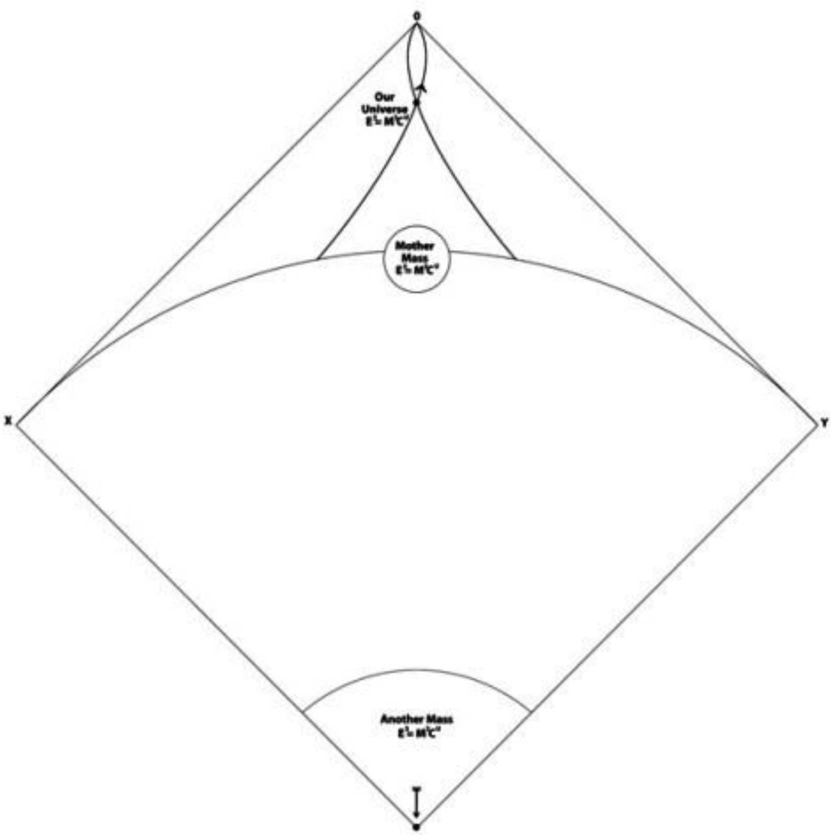

Figure 4

GEOMETRY FOR THE NEW MILLENNIUM

Contracting Space

Thus, it was around the end of the Seventies that I was contemplating a physics in which our known universe necessarily moves on a curve in relationship to other mass, that also moves on a curve in relation to another mass, and I was trying to imagine a geometry to contain everything I envisioned.

Having even less of a background in geometry than mathematics, I nonetheless spent some time thinking on the subject and began to make some simple drawings of what I saw in my mind.

I imagined our entire universe as but a speck of dust contained within a larger universe, which I could hold in the palm of my hand. Then, as I closed my fist and squeezed this larger universe, I imagined that I could compress it down to nothing, or zero.

In order to reduce this larger universe, geometrically, I first imagined that the entirety was contained within a cube, divided into eight quadrants, or component cubes. The center of each face is defined by one of the six Cartesian axes, and I pictured eight additional vertices extending from the center to each corner of the cube (A,B,C,D,E,F,G&H). The eight component cubes, or quadrants are each separated from the others by three perpendicular planes. (Figure 5)

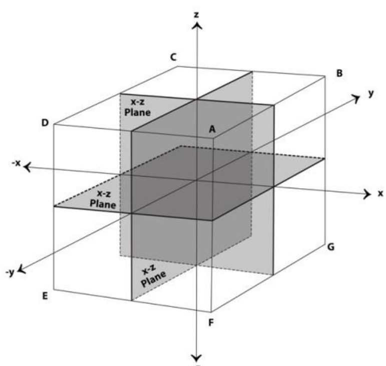

Figure 5

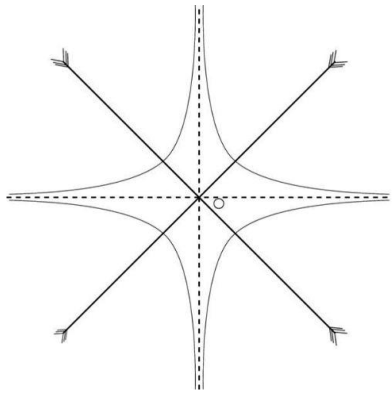

Figure 6

Relying on the eight new corner vertices, I imagined that each was a line upon which a focus could be centered from which to construct eight hyperbolic arcs. The concave surfaces of the hyperbolic arcs would all face outward, and the inner or convex faces would be focused inward toward their defining perpendiculars, which crossed at the center. Thus, two rectangular hyperbolas were doubled and then doubled again to complete the set of hyper-hyperbolic arcs, all facing the center. (Figure 6)

I then imagined that the eight hyper-hyperbolic arcs could be moved uniformly toward the center, occupying the space from each corner inward. Figure 7 demonstrates a single hyperbolic arc boring inward from one of the corners.

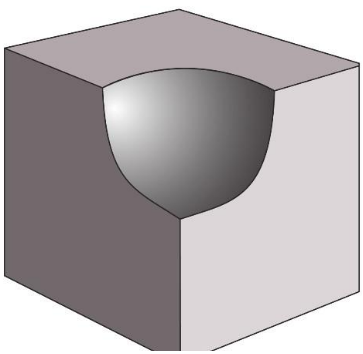

Figure 7

One must keep in mind that each hyperbolic curve and its tangents (the asymptotes) become parallel in infinity.[19] Therefore, each hyperbolic arc will ultimately occupy all of the space contained, not only within its quadrant in the larger cube, but in its 1/8 share of everything, as far as the mind can comprehend.

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[19] The tangents of hyperbolic curves are known as the asymptotes. In theory, although they never meet, the hyperbolic curve and its asymptotes will become parallel into infinity. Forever, in my memory will be the patient tutoring of Major Blake in my geometry class at the New Mexico Military Institute at Roswell in the spring of 1958, who for some reason kept saying, "The asymptotes, Mr. Cox, the asymptotes! You must remember the asymptotes." He generously gave me a grade of D in the class.

Finally, I imagined that every point in space defined by a Cartesian quadrant could also be identified on the face of its incoming hyperbolic arc by using its center vertex as a permanent polar coordinate emanating from the center.

Considering the three planes separating the stack of eight cubes (*See above* Figure 5), I began to illustrate the reduction of each quadrant through a series of drawings in which simple curves are substituted for the hyperbolic curves.

These three drawings illustrate the geometry of reducing or contracting space from the eight corners to the center in the eight quadrants on the three planes. Our universe can be imagined as a small dot (*p*) moving on a series of simple curves (AB) in the upper left-hand quadrant in each of the figures as each curve closes upon the center. (Figure 8)

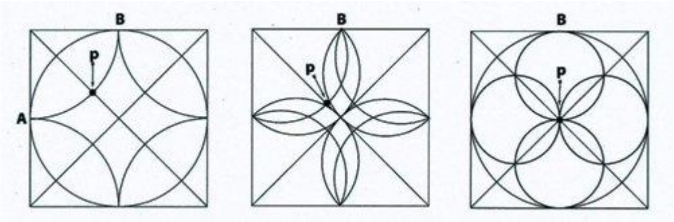


Figure 8

Expanding Space

As I studied these simple drawings, I tried to imagine what would be the effect of going through the center from every direction at once, to a place beyond. But, just as in Zeno's Paradox, modern mathematics encounter “Planck's Wall” just short of singularity where all calculations break down.

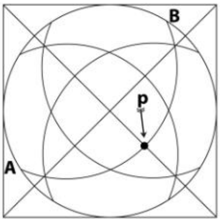


Figure 9

Undeterred by mathematical impossibilities, I picked up my compass and located four points halfway on the diagonals between the center and the enclosing circle, and constructed curves that intersected the diagonal points. This resulted in the drawing in Figure 9.

Looking at the drawing, the visual effect was to see the two-dimensional drawing appear to rise up into a virtual sphere, suggesting the drawing might be transferrable to the surface of a physical sphere.

Purchasing a couple of solid balls, approximately two inches in diameter, I began to experiment with my compass and determined that the drawing could in fact be reproduced on the face of a sphere by inscribing six lines divided into three pairs of perpendiculars. (Model 1)

Model 1

The six lines divide the sphere's surface into 24 equal geodesic triangles. Assuming the radius of the sphere to be equal to one, its circumference (C=2*Pi*r) will be equal to two times *Pi*, and, as one half of the circumference of the sphere can be measured by two equal legs and a hypotenuse, the perimeter of each triangle is necessarily equal to *Pi* times radius.[20]

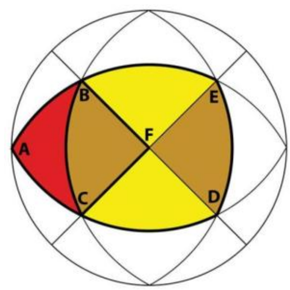


Figure 10

[20] A comprehensive search of the literature has revealed only one reference to the division of the surface of a sphere by six great circles. In Amy C. Edmondsons's *A Fuller Explanation*, about the work of Buckminster Fuller, she reports, "The octahedron's twelve edges consist of six opposing pairs, the midpoints of which can be connected by six intersecting axes. The same number of great circles are thereby generated, delineating another facet of the octahedron's symmetry. Unlike the previous case, the pattern made by six great circles does not look like an octahedron. Its twenty-four right isosceles triangles outline the edges of both the spherical cube and rhombic dodecahedron, as well as the edges of two intersecting spherical tetrahedra (otherwise known as the "star tetrahedron"), thus highlighting the topological relationship between these four systems."

Since a radius of one would produce a triangle bounded by 3.14159, I was curious to know the length of each side and the ratio of each side to the others.

These geodesic triangles appear to be right-angled, and, indeed, the right-angle theorem seems to hold (at least visually). The "square" on the hypotenuse of the red triangle (*See above* Model 1 and Figure 10 ABC.) can be seen to consist of two yellow and two gold triangles that form a curved square (BCDE) having the hypotenuses of the four triangles as its sides. Looking at the yellow triangle (CDF), we can see there is a parallelogram or diamond-shaped "square" (ABFC) on each leg made up of a gold and red triangle having equal legs on each side and divided by a hypotenuse.

Of the 14 vertices, six are the Cartesian axes that are centered on the six faces of an inflated "cube," with x on the right, z on the top, and -y facing you. The eight additional vertices define the corners of the cube and the center of its respective quadrant. (Figure 11, 1-14)

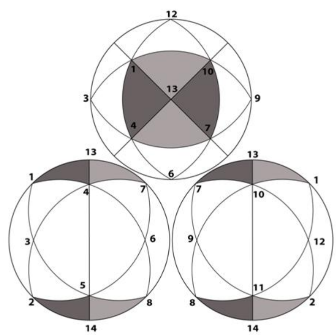


Figure 11

The hypotenuses which enclose each "square" face are the edges, and the legs are the diagonals on the face. However, no matter how much it may resemble a cube, it is still a sphere. Therefore, the first thing eliminated was that the ratio between the two equal legs and the hypotenuse was 1:1:square root2, any more than a box can be a ball.

Studying Model 1 (the original sphere) in an attempt to deduce the ratio between the sides of its 24 triangles, it appeared that the height on the "right" angle measured to the halfway point of the hypotenuse was equal to one quarter of *Pi*, as four such lengths could be seen to extend along the curve half way around the sphere.

Model 2

Another spherical model, identical to the first, was constructed. Three more lines were added along the heights of each of the 24 right-angle triangles. These lines cut each triangle in half at the hypotenuse on a perpendicular, resulting in the three new curves all being perpendicular to each other. (Model 2)

The nine great circles divide the sphere into 48 equal "half" triangles, and, as two sides (a leg and half hypotenuse) equal .5*Pi* and the height equals .25*Pi*, the perimeter of each new triangle is equal to .75*Pi* times radius.

Since each hypotenuse was cut in half, each "leg" of the full triangle becomes a hypotenuse in the new "half" triangle. These "half" triangles are defined by 26 vertices enclosing 48 three-sided pyramidal plugs.

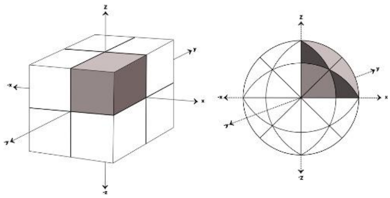


Figure 12

The six Cartesian axes still correspond to the six vertices defining the face of a cube, and of the remaining 20 vertices, eight still define the center of each Cartesian quadrant, or the corners of a cube, and the last 12 divide the 90º angle between adjacent Cartesian axes in half. Thus, every pyramidal plug continues to be defined by an existing Cartesian axis, and every internal point can be measured by an associated polar coordinate. (Figure 12)

Just as the three positive Cartesian axes have an inverse axis, each of the 13 positive coordinates based upon the proportions of *Pi*, also has its inverse or negative representation.

With the introduction of the three additional lines, the original eight Cartesian cubes and their coordinates are more readily identifiable, and can be seen on the face of the sphere as demonstrated in Figure 12.

Shapes Within Shapes

I could readily see that the sphere was defined by all 26 vertices being of the same length, and I wondered if the same set of *Pi*-based coordinates could be used to define other shapes as well.

Starting this time with a solid cube of hardwood, the exterior surface was inscribed with similar lines describing 48 "half" triangles. (Model 3)

Model 3

Next, four alternative corners were sliced from the cube along the diagonals, revealing an internal tetrahedron, which was similarly inscribed. (Model 4)

Model 4

Finally, the pyramid-tips were cut from the tetrahedron, revealing an internal octahedron. Each of these polyhedrons can be described by differing lengths of the 26 vertices. (Model 5)

I wish I could say that the making of these models was as easy as the writing of this short description, but there were a number of rough cuts until, finally, reality caught up with fantasy and the year I had taken off to think about these and other leisurely pursuits ended.

Model 5

I wrote up as best I could the physics, geometry, and mathematics I had contemplated and set about to earn a living. But, from time to time, I would take out my notebooks and models and would try to work out the ratios between the sides of the "half" and the "full" geodesic triangles.

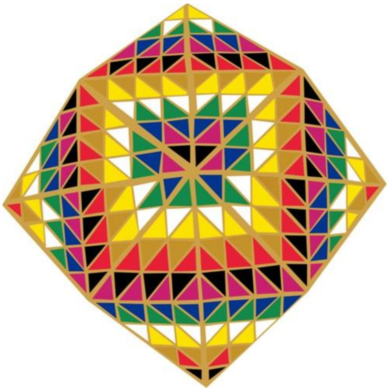
I suspected that if I possessed the knowledge of an average college math student with a basic understanding of spherical trigonometry, I could probably calculate the proportions, but it presented a logical problem I wanted to solve for myself.

I continued to review the current literature and to study various texts to educate myself, basically, and to barely stay afloat in the rising tide of new discoveries that wash over us daily.

The *Phi*ramid

The years passed and in 1991, I again found myself involved in another high-profile *pro bono* legal case that took much of my energy for more than a year. Once the matter was successfully resolved, I again sought escape from the law in games of the mind. A year or so passed as I worked with my models of expanding space and imagined things that are difficult for words to describe.

One day, I wondered if the Golden Proportion of *Phi* played any role in defining the ratios of the "full" triangle. Since I knew that the height equaled .25*Pi*, I divided *Pi* by the Golden Proportion. I then divided the Golden Proportion of *Pi* in two halves and used them as a measure for the two equal legs of the "full" triangle, and the remainder as the hypotenuse.



Model 6

Then, using the proportions of (*Pi*/*Phi*)/2:*Pi*-(*Pi*/*Phi*):.25*Pi*, I laid out a "half" triangle and used it as a pattern for cutting 48 cardboard clones. These were joined together, and, to my pleasant surprise, they produced, not a spherical model, but a 12-sided polyhedron consisting of diamonds, or rhombuses on each face. (Model 6)

In essence, it appeared that the cube had doubled its volume by raising up a four-sided pyramid on each face equal to its 1/6 share of the cube's internal volume.

Model 4 is defined by the 14 vertices (V) corresponding to the corners and faces of the original cube and sphere, by 24 edges (E), and by the 12 faces (F), thus conforming to Euler's formula for polyhedrons (V-E+F=2) in that 14-24+12=2.

Although the *Phi*ramid model was interesting in that its pyramids could be folded inside themselves, and its diamonds were pleasing to the eye, it still failed to provide the correct proportions of *Pi*.

In the final analysis, it was easy to see that, since the value of *Pi* used to describe the sides of the triangle could be replaced by one or any other number, it was actually the function of the Golden Proportion that had defined the ratios and the shape of the resulting model.

A Discovery of Pleasing Proportions

A couple of years later, in 1995, I dusted off the *Phiramid* model and wondered at the model that would result if the centers of each of its 12 diamond faces were raised to the same height as the other vertices in the same manner that the cube had raised up pyramids on its faces.

Still incapable of calculating it directly, I began to experiment with different ratios. One day, I hit upon a set of pleasing proportions, in which the 90º angle of the "full" triangle is slightly reduced and the height is slightly lengthened. The result is a rhombus-shaped "full" triangle with a "tail."

These proportions, 21:21:38, resulted in the hypotenuse (38) being divided and pushed out into two lengths of 19:19 by a lengthened height of 14. These measurements produce a perimeter of 80 for the "full" triangle and 54 for the "half" triangle.

To determine the proportions of each "half" triangle, 54 can be divided by each proportion to determine the length of each side. Thus, 54/14 equals 3.857142857, 54/21 equals 2.57142857, and 54/19 equals 2.842105263.

As a curiosity, it appears that these measurements of the "half" triangle are related to the ancient value for *Pi* derived from 22/7 (3.142857), in that 0.142857 divides the circumference (54) 378 times, each leg (21) 147 times, the hypotenuse (38) 266 times, and the height (14) 98 times.

A triangle was constructed using these measurements, and it was quickly discovered it could be rotated to join with five others in tessellating into a flat, six-sided polygon. Then, the polygon can be rotated three more times, resulting in a drawing that can be cut, folded and joined into a half dome. (Figure 13)

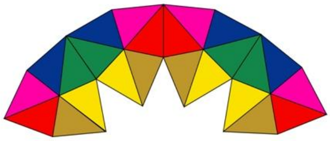


Figure 13

When two halves are joined together, a model can be constructed consisting of eight flat, six-sided polygons composed of three half diamonds or rhombuses. Each of these polygons can be folded and joined together for a total of 48 surface planes, 72 edges, and 26 vertices, which again conform to Euler's formula (26-72+48=2). (Model 7)

Model 7 appears to have an architectural application, most readily as a tent or dome. The twin structure of inside and outside straight lines surrounding an enveloped spherical dome suggests that it would have utility in bearing the stress of compression.

Model 7

Basketball Billiards

Although the results of Model 7 were more than pleasing, and there were now pyramids on the 12 diamond faces of the *Phiramid*, the model still did not appear spherical.

At this point the surface of a basketball was plastered until it was as smooth as a billiard ball. Using large compasses and curved vinyl straight edges, it was inscribed in the same manner as Model 2.

Then, focusing on a single large "half" triangle, each line and diagonal was reduced into increasingly smaller lengths. It finally had to be concluded that it would be impossible to ever construct a fully spherical model with three-sided right-angled triangles because the height on each triangle necessarily traverses a greater proportional distance on the face of a sphere than on any flat or planar surface.

However, by using the measurements obtained from the basketball, another set of pleasing proportions was discovered that resulted in a "full" triangle based upon 44:44:57, with a perimeter of 145, and a height of 36.

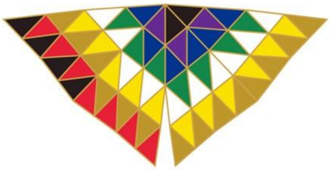


Figure 14

This finding resulted in the two half hypotenuses beings slightly indented and the legs slightly extended in two halves. Thus, the "full" triangle had been extended into an eight-sided polygon, which, when joined with another, looked like the wings of a beautiful butterfly. (Figure 14)

Model 8

Using one half of the "full" triangle and the proportions 28.5:36:44, 48 identical "half" triangles were cut out of cardboard, each divided into 16 facets and folded into four planes each. Once assembled, rather laboriously, the resulting model finally began to look spherical. (Model 8)

Just as Model 7 had immediately suggested an architectural utility, Model 8 also appears to provide an effective method of stress and compression management with very elegant lines.

The results of Model 8 were quite pleasing; however, they failed to satisfy my thirst for the sweet waters of *Pi*-perfect proportions.

Accordingly, I reconsidered the large "full" triangle on the face of the basketball and again carefully measured its dimensions.

From my observations, it seemed that the more I had struggled with complex numbers over the years to define the "full" triangle, the more the complex numbers always seemed to resolve themselves into ever more logical and simpler proportions.

Finally, one day, I concluded that, although the proportions 44:44:57 and 36 used in Model 6 were close, the more accurate ratios seemed to be 43.5:43.5:58 and 36.25, for the same perimeter of 145 (44+44+57=145 and 43.5+43.5+58=145).

Figure 15

Using these new ratios, each side and the height can be divided by 14.5 to reduce the proportions to exactly 3:3:4:2.5. The .25*Pi* height of 2.5 divides the hypotenuse of four into two parts of two. (Figure 15)

The 3:3:4:2.5 "full" triangle was less complex, and perhaps even more elegant in its simplicity than the lovely butterfly wings of Figure 14. It readily allowed itself to be rotated into a drawing which, when folded and assembled, resembled a somewhat spherical dome in which every reduced triangle folds into a facet as the plane surface easily wraps around the sphere. (Model 9)

Model 9

This design allows a *Pi*-based dome to be entirely constructed using structural beams in the simple lengths of 3, 4 and 2.5. (or 1.5, 2, and 1.25). It should provide greater engineering strength and resiliency than a comparable "Bucky Dome," or any other hollow spherical object subject to compression.

Although every point on the surface of a spherical dome constructed of rotating equiangular triangles, or any hollow sphere, is as strong as any other point, each point is equally as weak, and such domes and spheres are subject to explosive and disastrous consequences when any point is penetrated or breached.

Buckminster Fuller (1895-1983), the inventor of the "Bucky Dome," once said, "When I am working on a problem, I never think about beauty. I think only of how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong."[21] I hope that if Fuller was living today he would consider the *Pi*-based domes to be visually pleasing as well as utilitarian.

A Mathematical Solution of the Pi Proportions

Although it appeared from experimental observation that the ratio 3:3:4:2.5 for the "full" triangle was correct, I was initially unable to verify it mathematically.

I visited with several professors of mathematics and found that the solution was not as simple as I had originally believed. However, with advances on the Internet, I was able to locate several sites that provide various formulae for calculating spherical trigonometry problems. Relying on these, in 2006, I was finally able to mathematically prove the correct ratios of the geodesic triangles, as follows.

If A and B are two points on the surface of a sphere and C is the center, then the distance between A and B along the great circle connecting them can be determined by using the formula [d(A,B) = Ra], where R is the radius, a is the angle of ACB measured in radians and d is the distance between A and B.

[21] Livio, Mario, *The Golden Ratio*, (Broadway Books, 2002), p. 10.

To determine these distances, we can first divide each of the ratios 3:3:4:2.5 by three to reduce the distance of each leg of the full triangle to one, the hypotenuse to 1.333333, and the height to 0.833333. If we divide the combined perimeter of 3.333333 by *Pi*, the producing radius would be 1.061032954.

Next, we can use the formula [a (angle) = (180 x distance) / (radius) x *Pi*] to determine that the internal angle for each leg (1) is 54º, the internal angle for each hypotenuse (1.333333) is 72º, and the internal angle for each height (0.833333) is 45º. Since 2*Pi* radians are composed of 360 degrees, we can calculate that the internal angle of each leg is 0.942477 radians, of each hypotenuse is 1.256637 radians, and of each height is 0.785398 radians.

In addition to observing the perimeter of each "full" triangle to be equal to *Pi*, the only other known distance results from an observation of the "half" geodesic right-angle triangle in Model 2, which consists of the height, one side, and one-half of the hypotenuse of the original "full" triangle.

By observation, the former height must be equal to .25*Pi* (assuming a radius of one), inasmuch as the circumference of the sphere demonstrated by each imaginary great circles can be seen to be exactly divided into eight such lengths. Using this known distance (and assuming a radius of one), we can use the formula [d(A,B) = Ra] to determine that the height measures 0.785398, or .25*Pi*—the same as 45º expressed in radians. Thus, we can conclude that the proportion of 2.5 is the same as .25*Pi*xa and that it accurately produced the correct angle in radians.

We can use the same logic (assuming a radius of one) to also measure the hypotenuse and two legs of the full triangle. If the hypotenuse's internal angle is 1.256637 (72º expressed in radians) we can conclude that the distance of the hypotenuse is 1.256637. And, if the internal angle of each leg is 0.942477 (54º expressed in radians) we can determine that the distance of each leg is 0.942477. When the distances of two legs and the hypotenuse are added together, the result is 3.141591, or *Pi*.

To prove the proportions are correct, we can first calculate the area of each individual geodesic triangle by using the formula [a (area) = r^2(A+B+C)-*Pi*], in which A, B, and C are the angles measured in radians at the vertices on the surface of the sphere.

From observation, we can see that each triangle has two 60º and one 90º angles. Since each radian is equal to 0.0174532 degrees, we can establish that A and B are equal to 1.047197 radians and C is equal to 1.570796 radians, for a total of 3.66519 radians. When *Pi* is subtracted, and assuming a radius of one, the remainder is 0.523597, the area of each individual "full" triangle.

Finally, we can use the formula [a (area) = 4*Pi*r^2] to establish the area of a sphere with a radius of one to be 12.566370. If we divide the total area by 24, we find that each "full" triangle has an area of 0.523598, the same result we obtained above.

Thus, it can be mathematically proven that 24 geodesic triangles having sides equal to the proportions 3:3:4:2.5 completely tile the surface of a sphere, and are, therefore, equal and congruent.[22]

Related Numbers

The ancients used a special right-angle triangle, based on the golden proportion and known to them as *mr*, to calculate the value of angles used in basic trigonometry. The *mr* was constructed with a side

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[22] The mathematical elegance of these *Pi*-based triangles was demonstrated by Littlejohn, Robert G., Kevin A. Mitchell, and Vincenzo Aquilanti in "Quantum dynamics of kinematic invariants in tetra-and polyatomic systems," *Phys.Chem.Chem.Phys., 1999, 1, 1259-1264*. They rely upon the earlier work of Mangus, W., *Noneuclidean Tesselations and Their Groups,* (Academic Press, 1974) to identify the full triangle as having surface angles of *Pi*/2, *Pi*/3 and *Pi*/3, the distance of the height arc as *Pi*/4 and the arc of each side as being $\cos^{-1}$square root1/3. Illustrations also demonstrate a tetrahedral tesselation of the sphere by 24 Moebius triangles of angles *Pi*/2, *Pi*/3 and *Pi*/3 and an octahedral tesselation by 48 Moebius triangles of angles *Pi*/2, *Pi*/3 and *Pi*.

of 72.6542, a base of 100, and a hypotenuse of 123.6068 (2/*Phi* x 100), producing a 36º angle between the hypotenuse and the base leg and a 54º angle between the hypotenuse and the side.

Ancient mathematicians also used a pentagon inscribed inside a circle to calculate other basic trigonometric functions in the same manner as the *mr* triangle, such as Sin 18º = .5*Phi*, Sec 36º = 2/*Phi*, Sin 54º = *Phi*/2, and Sec 72º = 2*Phi*. Thus, we can see that both the 54º and 72º angles of the *Pi*-based triangles are related to the golden proportion, as well as to *Pi*.

Another number that is related to the proportions of 3:3:4 can be found in the work by Archimedes in his attempts to solve the difficult problem of measuring parabolic curves. He constructed a parabolic curve and began to divide its interior by triangles in proportionally reducing its area in a geometric progression. Assigning one as the area of the triangle, he found that the fraction 4/3 (1.33333333) defined the practical limits of progression as the narrowing triangles approached the infinite.

The volume of a sphere [V = 4/3*Pi*4^3] also relies on the same fraction, as does the basic definition of the hypotenuse of the geodesic "full" triangle set forth in the above solution.

Practical Utility of Millennial Geometry

As beautiful as the models were and as elegant as the mathematical solution of the ratios is, one has to ask if there is any practical benefit to *Millennial Geometry*?

One answer to that question lies in an understanding that the surface of any given model, of every size and shape, can be described by the geodesics of the solution, all the way from the infinitely small to the universally large.

Looking back at the spherical Models 1 and 2, and imagining them as small inflated cubical balloons, you can imagine that, with enough pressure, you could hold either in the palms of your hands and squeeze it down to nothing and then through the center and back out along the inverse coordinates.

As the model then grows outward from the center, you could begin to see the tips of the vertices coming to glow just under the skin on the backs of your clenched hands, poised to expand into infinity.

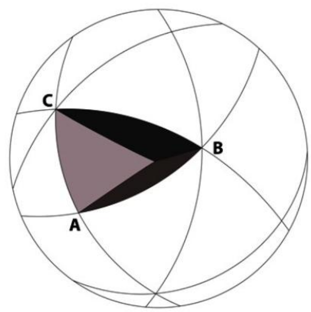

Figure 16

The 24 triangles of Model 1 are defined by 14 vertices, any adjoining three of which have a perpendicular or right angle relationship to each other at every distance from the center to the surface. Therefore, any point within each three-dimensional pyramidal plug can be defined by reference to the three adjacent vertices in a similar manner as to three Cartesian axes, as well as by the use of polar coordinates. (Figure 16, ABC)

Thus, from three perpendicular Cartesian axes, which are extended into a total of six positive and negative vertices, we now have seven perpendicular vertices, or *Pi* coordinates, which extend through the center for a total of 14.

In like manner, the spherical surface of Model 2 can be defined by 26 vertices, as was the cube in Model 3, the tetrahedron in Model 4 and the octahedron in Model 5.

The several practical applications of the geometry of expanding and contracting space are based on the fact that any triangle can be divided into four equal triangles by drawing three lines connecting the half point of each side, and each succeeding triangle can again be divided in the same manner *ad infinitum.* (Figure 17)

First, each *Pi*-based triangle on the surface of all of the models can be divided as needed into an infinite number of smaller spherical triangles, resulting in additional vertices, all having a fixed angular relationship to a fixed Cartesian axis and an inverse negative representation.

As the distance increases from the center of any object, more triangles and vertices can be added to intensely define its surface topography, irrespective of variations, and every point within its interior space.

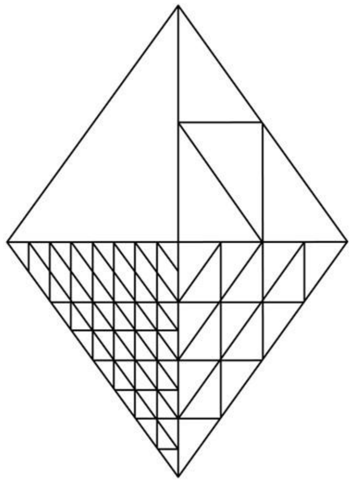

Figure 17

Accordingly, any object may be accurately represented by a coherent strategy of geometric coordination based upon a rational subdivision of each *Pi*-based triangle and a corresponding increase in the number of vertices required to plot the object.

Secondly, the same system of division can be applied to the construction of architectural domes based on Model 7. The identification of basic proportions allows for the construction of highly stable and easily constructed structures, since all dimensions are based on the proportions of 3:3:4 and 2.5.

A Gateway to Relative Dimensions

In this brief introduction to *Millennial Geometry*, we have been asked to imagine that our entire universe was but a small dot moving along the simple curves on flat planes in the first cubical models of contracting space. We then saw the small dot of our universe reproduced on a hyperbolic arc and contained within an expanding *Pi*-based geometry sufficient to include the mega-mass that gave birth to our universe and another eternal mass about which it revolves.

A more comprehensive system of *Pi*-based coordinates may provide the ability to raise ourselves above this flat plane we call the universe and to use the velocity of light provided by adjacent dimensions to get where we want to go, and to spin back in, either here on Earth or elsewhere in the universe, at this time or another. Such travel on Earth, from here to there, would be essentially timeless.

The only problem is that, while we can imagine this physically and geometrically, the numbers must also work, or else the computer in its senseless, binary fashion will not put you where you want to go, but 20 feet under the point you thought you were going, which may result in a shock to both mind and mass.

BASE-10 MATHEMATICS

In an *Introduction to Arithmetic*, written by Nicomachus of Gersa (ca. 60 - ca. 120 C.E.), we find an extensive review of the relationship of numbers as known and understood at the time. Viewed abstractly, numbers were seen almost as solid bodies (or counters), and their relationship to each other was considered in three proportions—mathematic, geometric, and harmonic.

To help solve these proportions, Nicomachus used a multiplication matrix. This device allows one to quickly determine the squares of whole numbers on the diagonal from one to 100 and to perform other calculations, such as division and multiplication. (Table 1)

1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100

Table 1

According to Nicomachus, all the ancients, including Plato and Aristotle, recognized ten (10) as the most perfect number because ten was the sum of all known and proven mathematical proportions. However, the fact that humans have ten fingers and ten toes continues to provide the most persuasive evidence that this particular number should be the logical basis for arithmetic.

Although the ancients calculated with various numerical systems based upon six, seven, 28, and 60, the later Egyptians also used a base-10 system of counting similar to Roman numerals in which one through nine are noted by vertical lines, and tens are noted by an upside down U, or "heelbone." Hundreds were represented by a scroll, or coiled rope, that appears to be a ? mark, and there were additional symbols for thousands and ten-thousands.

The ability of the ancient system to accommodate multiple bases may have been demonstrated by the use of *Horus* (depicted by a falcon) for 10, and the use of two falcons to represent *ou ou*, or 28, indicating that each could be a base number.

With a base-28 system, 100 would be equal to 784 (28^2), and the matrix would encompass the first 14 numbers of the Fibonacci series. At this point fairly accurate values for both the Golden Proportion and *Pi* would be produced.

The Greeks also used a base-10 system in which they substituted their written alphabet as symbols and used the principle of addition for intermediate numbers, as well as a system of notation to indicate multiplication by thousands.

In their conquests, beginning in the Seventh Century, the Muslims borrowed widely from all existing civilizations within their sphere of influence. From the Hindus, the Muslims adopted the decimal system of mathematics, with its concept of zero.

Although the symbols they used were then, and continue to be, slightly different from those in common use in the West, the introduction of the notation system provided the foundation upon which the entire structure of modern mathematics is built. With it came the ability to express all fractions, percentages, and whole numbers with precision, economy, and predictability.

Several examples of the utility of the decimal system of notation might be of some value. In the expression of irrational and transcendental numbers, it is apparently possible to indefinitely extend proportions to the right side of the decimal.

For example, the value of Pi, 3.14159+, has been extended to trillions of places by modern computers. The addition of each new number modifies the one which preceded it into a new and slightly different proportion, and ultimately, a more accurate estimation of exactly where the curved line will meet the tip of the revolving radius.

The decimal system also provides the ability to measure great distances and to count large numbers with equal precision. The places to the left of the decimal can be divided by commas every three numbers to define thousands, millions, billions, or trillions of units of distance, volume, weight, time, or any measurable subject in an endless fashion.

Thus, the length of expression is limited only by the size of paper necessary to write the strings of symbols that define very large concepts, such as those involved in space travel, and the very small, such as the structure of an atom.

Let us pretend we are in ancient Greece seated at a huge white marble table. An endless supply of perfectly square black marble counters is on the table. If we stack ten cubes across, ten deep, and ten high, we end up with 100 on each face and 1,000 in a new and larger cube. In this simple configuration, the value of one remains one throughout the cube.

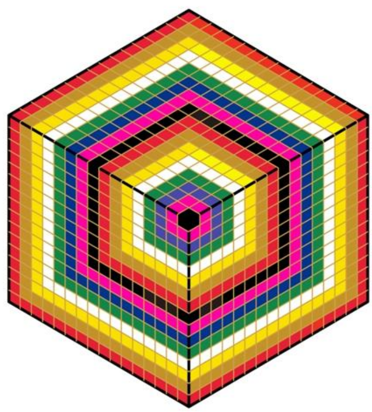

Figure 18

To demonstrate a great number, we can obtain a supply of multicolored cubes and add more counters to the stack until there are 16 across, 16 deep, and 16 high. The resulting cube has 256 cubes on each face and a total of 4,096 cubes in the new and larger cube. (Figure 18)

This is not yet a great number; however, let us focus in on the top left corner of the stack, and assign a value of 64 to the single small black cube found there.

If we next focus on the second row of violet cubes, we can visualize the next larger size cube composed of two across, two deep and two high. If all eight cubes are multiplied times 64 (the value of the black cube), we determine the value of the violet "two" cube to be 512.

If we then visualize the "three" cube with its 27 blue cubes, each having the violet cube value of 512, for a total of 13,824, we can begin to project our way through the entire cube, as the value of one in each succeeding cube is based upon the total of the cube which preceded it. If this process is carried out through the entire "sixteen" cube, we will have then "cubed" the stack. The simplified equation is:

$$64(2^{3}\cdot 3^{3}\cdot 4^{3}\cdot 5^{3}\cdot 6^{3}\cdot 7^{3}\cdot 8^{3}\cdot 9^{3}\cdot 10^{3}\cdot 11^{3}\cdot 12^{3}\cdot 13^{3}\cdot 14^{3}\cdot 15^{3}\cdot 16^{3}) =$$
$$586{,}190{,}472{,}309{,}210{,}600{,}000{,}000{,}000{,}000{,}000{,}000{,}000{,}000.$$

Most would consider this to be a very large number. Since it extends 42 places to the left of the decimal, it exceeds the 39 places commonly conceded as being sufficient to accommodate most practical calculations.

Such large numbers can be abbreviated by expressing strings of zeros as powers of the number they follow. For example, 1,000,000 can be expressed as 10^6 or as 10 to the 6th power, which number is known at the exponent. Thus, the above result can also be written as 5,861,904,723,092,106 x 10^{26}.

Another way of looking at it is to see that the exponent is the ratio between the two numbers—indeed, the word, logarithm, means ratio number. The system of logarithms created by John Napier (1550-1617) and the calculus developed by Newton to manipulate such large numbers was necessary before there could be anything like the industrial revolution, travel to the moon, and, sadly, the atomic bomb.

COMPUTER LOGIC

The use of base-10 mathematics has prevailed for thousands of years until the present generation, during which electronic computers introduced binary or base-two logic into the vocabulary of most who read this.

Those concerned with the actual programming of computers see their machines much like a simple-minded person, without fingers or toes, who counts everything 0-1, 1-2, or just plus or minus. The only thing is that these "idiot savants" are able to count these simple "bits" in a lightning-like fashion limited only by the hardware and our ability to accurately define its operating software.

The number two, and its multiples provide the essential basis of modern computer sciences. These disciplines primarily use bases two, eight, and sixteen to communicate with computers. Each base is capable of counting and displaying predictable numbers. Thus, had we evolved with but a single finger and thumb on each hand, we may never have progressed beyond base-four mathematics or, given three fingers and a thumb on each, we may have used a base-eight language.

The essential point is that each of these bases, including base-10, is a multiple of two. Were there but one of everything, a head without even an armless and legless body, perhaps there would be no number two, or even a need for the number one, or anyone to care.

Another logical extension of numerical bases is found by going inside the "brain" of a modern computer. Computers designed to be electronically connected to other computers are programmed with a base-16, hexadecimal language, commonly known as ASCII, or

American Standard Code for Information Interchange. It is expressed serially as 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10.

One value of a hexadecimal language to computer programmers is its ability to accommodate the assembly of individual "bits" into "bytes" of eight so that the computer can gulp two of them in a mouthful of 16 and economically and faithfully inform another computer of its diet.

The rapid expansion of computer hardware capacity now allows software to also be written for 32- and 64-bit processors. In addition, some 128-bit applications are being written by combining four 32-bit floating-point numbers, and some 256-bit processors are based on quad 64-bit processors.

In ASCII, base 10 is extended by the insertion of symbols A through F between nine and ten. While it does not matter to a computer which symbol, or base, is used to express its binary calculations, it becomes readily apparent that few humans have the ability to mentally compute even the simplest problems in ASCII. Indeed, computer programmers have no interest in the actual calculation of ASCII numbers, only in their whole number designations.

A computer must not only do the task of working out the problem in whatever language it is programmed, but it must also translate its answer into a language usable to the operator. What follows is a brief study of what happens if we tune our base numbering system to the harmonies of the computers we have come to rely upon.

Following her review of the evolution of base 10 in *The Joy of Mathematics*, Theoni Pappas asks, "Someday, as our needs and ways of computing change, will a new system evolve and replace base ten?" An answer to her question is suggested by the next chapter.[23]

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[23] Pappas, Theoni, *The Joy of Mathematics*, (Wide World Publishing/Tetra, 1986), p.3. As a teacher of mathematics, Ms. Pappas' excellent series of books on the subject is a delightful addition to every library where curious children gather.

MATH FOR THE NEW MILLENNIUM

Years ago, when I was first struggling to mathematically describe my images of contracting and expanding space, I found my efforts always produced numbers greater than 10 and often involved fractions.

One day, as I sat in a hotel room in Washington, D.C., looking out at the Capitol building, I imagined our base-10 system could be harmonized by inserting new symbols "U" and "N" for the squares and cubes of two.

In a traditional base-12, or duodecimal numbering system, the symbols "A" and "B" are added after 9 and before 10. In smoothing out base-10, it seemed essential to tamper with the existing relationship of symbols with the lightest touch possible. Thus, the symbol "U" was delicately placed between three and four and the symbol "N" between six and seven. The serial language produced is 1, 2, 3, U, 4, 5, 6, N, 7, 8, 9, 10.

In this way, we retain the natural spoken harmony of the language and maintain the same relative ratio of existing numbers to ten. However, it is necessary to learn a few new symbols, such as a "1U," and new terms, such as a "Uteen." (Hereinafter all base-ten expressions (except footnotes, figures, and tables) will be underlined.)

I made a multiplication matrix, similar to that of Nicomachus, and a table for converting base-10 numbers to base-12. I then began to experiment with the system to see if it was more useful in describing *Millennial Geometry*.

The new numbering system was quite enchanting and seemed to provide a greater sense of harmony in the manipulation of numbers. Ten is divisible by two, three, U, and five; however, nine (11), being prime, is not divisible at all. In the multiplication matrix, the value of 100 is equal to 144, which is 11th Fibonacci number, thereby providing an additional dimension.

However, the more I struggled to mathematically describe *Millennial Geometry*, the more I continued to be put off by the appearance of numbers larger than 10, particularly for 16 and 64, which appeared to be basic to its definition. Therefore, I began to experiment with an expanded base.

Ancients who wrote about mathematics were as much impressed with the beauty of arithmetic as with its utility. In working out the geometry of space and consistently encountering multiples of 16 and 64, it seemed that a hexadecimal, or base-16 language was the most useful.

New symbols were added, and it quickly became apparent that there is great harmony and beauty in a 16-base numbering system in which 2+2=U, U+U=N, N+N=10, or 2^2=U, 2^3=N, 2^U=10, and in which 16=10, and 64=U0.

So, if we again pick up our transient "10" and move it four, or U, places to the right, we again have to insert new symbols for the jumped numbers. Perhaps we can use a (S), or "star", a (C), or "see", an (X), and a (W), or "Dub", to produce the serial language: 1, 2, 3, U, 4, 5, 6, N, 7, 8, 9, S, C, X, W, 10. The keyboard uppercase symbols S, C, X, and W can be used in typing or computer operations, and the lowercase "x" can continue to be used to denote multiplication.

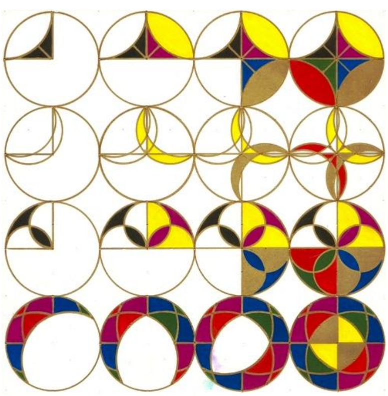

Figure 19

Figure 19 demonstrates the selection of these additional symbols as based upon the geometric representations used to demonstrate the contraction and expansion of space (*See earlier* Figures 8 and 9), and, except for "X," they are not normally used in mathematical formulas.

"W" was chosen in recognition of the *ou ou*, or WW, that represented 28 in the ancient Egyptian numbering system.

In learning the language of numbers we have to accustom ourselves to reassociate certain words and symbols for the numeric sequence. Thus, when we hear "four," we now automatically associate it with four fingers or whatever the reference is, but that is no longer the case.

In working with *Millennial* numbers, at least initially, one has to suspend this habitual association and accept that "four" now means five and that the concept of what was formerly "four" is now represented by a "U."

With a little practice and by reference to the following tables, you should begin to appreciate that the use of new symbols for the powers of two has sufficient value to continue the exercise. At least, let it be a mind game to enhance your appreciation of the magic of numbers.

1	2	3	U	4	5	6	N	7	8	9	S	C	X	W	10
2	U	5	N	8	S	X	10	12	1U	15	1N	18	1S	1X	20
3	5	7	S	W	12	14	1N	19	1X	21	2U	26	28	2C	30
U	N	S	10	1U	1N	1S	20	2U	2N	2S	30	3U	3N	3S	U0
4	8	W	1U	17	1X	23	2N	2C	32	36	3S	U1	U5	U9	40
5	S	12	1N	1X	2U	28	30	35	3S	U2	UN	UX	4U	48	50
6	X	14	1S	23	28	31	3N	3W	U5	UC	4U	49	52	57	60
N	10	1N	20	2N	30	3N	U0	UN	40	4N	50	5N	60	5N	N0
7	12	19	2U	2C	35	3W	UN	41	48	53	5S	64	6X	N6	70
8	1U	1X	2N	32	3S	U5	40	48	5U	5X	6N	N2	NS	75	80
9	15	21	2S	36	U2	UC	4N	53	5X	67	NU	NW	78	84	90
S	1N	2U	30	3S	UN	4U	50	5S	6N	NU	70	7S	8N	9U	S0
C	18	26	3U	U1	UX	49	5N	64	N2	NW	7S	87	95	S3	C0
X	1S	28	3N	U5	4U	52	60	6X	NS	78	8N	95	SU	C2	X0
W	1X	2C	3S	U9	48	57	6N	N6	75	84	9U	S3	C2	X1	W0
10	20	30	U0	40	50	60	N0	70	80	90	S0	C0	X0	W0	100

Table 2

Before doing any calculations in *Millennial Math*, it helps to construct a multiplication matrix and a derivation table. Color has been added to Table 2 to help illuminate the values of the different numbers.

			10^1	10^2	10^3	10^4	10^5
1	=	1	8	5U	3XN	2:61 0	1N:580
2	=	2	1U	SN	6C0	U:X20	30:CU0
3	=	3	1X	12S	99N	6:43 0	U7:3X0
4	=	U	2N	170	W80	7:SU0	51:8 N0
5	=	4	32	1WU	1:3N N	S:3 40	68:1 20
6	=	5	3S	24N	1:66 0	X:850	72:6 S0
7	=	6	U5	29S	1:94 N	11:1 60	88:X 50
8	=	N	40	320	1:WU0	13:N N0	S3 :400
9	=	7	48	3NU	2:32 N	14:W7 0	C9 :980

Table 3

The multiplication matrix can also be used to determine the number of cubes in the "sixteen" cube of Figure 18 by substituting the value of 10 for 16 and by "cubing" 10, (10x10x10), for a total of 1:000.

A derivation table of equivalent values is very useful in converting base-ten numbers to the *Millennial* system. (Table 3)

The *Millennial* value for 4,096 can be easily determined by using the derivation table (Table 3) and the following addition and subtraction table (Table 4) to add the equivalent numbers:

4,000 (W80) + 90 (48) + 6 (5) = 4,096 (1;000)

To help differentiate between base languages, all expressions in base ten will continue to be underlined and separated by commas, and *millennial* numbers to the left of the decimal will be divided by semicolons (;).

Table 4 provides a simple addition and subtraction table that may also be of some value in calculating *Millennial* numbers.[24]

0	1	2	3	U	4	5	6	N	7	8	9	S	C	X	W	10
1	2	3	U	4	5	6	N	7	8	9	S	C	X	W	10	11
2	3	U	4	5	6	N	7	8	9	S	C	X	W	10	11	12
3	U	4	5	6	N	7	8	9	S	C	X	W	10	11	12	13
U	4	5	6	N	7	8	9	S	C	X	W	10	11	12	13	1U
4	5	6	N	7	8	9	S	C	X	W	10	11	12	13	1U	14
5	6	N	7	8	9	S	C	X	W	10	11	12	13	1U	14	15
6	N	7	8	9	S	C	X	W	10	11	12	13	1U	14	15	16
N	7	8	9	S	C	X	W	10	11	12	13	1U	14	15	16	1N
7	8	9	S	C	X	W	10	11	12	13	1U	14	15	16	1N	17
8	9	S	C	X	W	10	11	12	13	1U	14	15	16	1N	17	18
9	S	C	X	W	10	11	12	13	1U	14	15	16	1N	17	18	19
S	C	X	W	10	11	12	13	1U	14	15	16	1N	17	18	19	1S
C	X	W	10	11	12	13	1U	14	15	16	1N	17	18	19	1S	1C
X	W	10	11	12	13	1U	14	15	16	1N	17	18	19	1S	1C	1X
W	10	11	12	13	1U	14	15	16	1N	17	18	19	1S	1C	1X	1W
10	11	12	13	1U	14	15	16	1N	17	18	19	1S	1C	1X	1W	20

Table 4

When applied to the "sixteen" cube stack of counters in Figure 18, *Millennial Math* results in an even 10 across, 100 on the face, and 1:000 in the stack. If the value of the black "one" cube is now assumed to be U0, and the stack is cubed, the restated equation is:

[24] Since I was not particularly computer literate and did not have access to a hexadecimal calculating program, I used these tables for almost 15 years filling stacks of notebooks until my birthday in February 1997 when I was able to download a hexadecimal calculator from the Internet. This handy tool allowed me to reliably and easily calculate and convert *Millennial* numbers and to verify earlier calculations.

$$U0(2^3 \cdot 3^3 \cdot U^3 \cdot 4^3 \cdot 5^3 \cdot 6^3 \cdot N^3 \cdot 7^3 \cdot 8^3 \cdot 9^3 \cdot S^3 \cdot C^3 \cdot X^3 \cdot W^3 \cdot 10^3) =$$
$$5W;83N;594;309;9W4;WW0;652;57N;000;000;000;000.$$

Thus, the product required to express the same number of "bits" has been reduced from <u>42</u> places to the left of the decimal to <u>35</u>. However, as can be seen by comparing the product with that produced by base <u>10</u>, the proportional number of zeros is reduced and the proportion of other numbers is increased, resulting in a more complex answer.

The "Rounding Off" of *Pi*

Traditionally, *Pi* is understood to be the relationship of circles and spheres to their radii. Another way of viewing *Pi* is to see that it represents the concept of randomness itself.

If we select a needle and draw a series of parallel straight lines on paper separated by a distance greater than the length of the needle and randomly drop the needle on the paper, after a long time and lots of tosses, the number of needles that touch one of the lines will be equal to *Pi*, when divided into the total number of attempts.

This game of "randomly" deriving *Pi* became known as the Monte Carlo Method and was attempted during the Eighteenth and Nineteenth Centuries, both actually and mathematically. In a more recent computer simulation, the method produced a value of 3.1417725 after 12,000 electronic tosses.[25]

The Monte Carlo Method was the beginning of probability theory, which is at the heart of modern mathematics. Today, physicists and engineers realize that the only way to describe the real world exhaustively is by laws governing randomness.

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[25] One of the best published works on *Pi* for the lay reader was written by the late Petr Beckman, *A History of π (Pi),* (St. Martin's Press, 1971). I discovered his work many years ago and am certain that this book could never have been written without his inspiration. I once had the honor of speaking with him on the telephone, and although nearly blind and in poor health, he graciously found the time to discuss some ideas I had at the time about *Pi.*

What was once considered to be exact is now seen as the mean value of unlimited random events, such as the probabilistic laws of quantum mechanics. Thus, the number *Pi* appears very frequently in probability theory, as well as in all areas of higher mathematics.

The value of *Pi* was one of the first problems I wanted to solve after creating *Millennial Math*. To test the usefulness of *Millennial* numbers, I started with the ancient base-10 fraction 22/7 (which may have been used to lay out the Great Pyramid).

In the third century B.C.E., the Classical Greek scholar Archimedes of Syracuse (ca. 287-212 B.C.E.) used rudimentary algebra to construct two imaginary polygons of 96 sides inside and outside a circle to determine that the value of *Pi* stood between the product of 3 10/71 and 3 1/7 (which results in 22/7).

Solving the fraction produces an approximation of *Pi* as 3.142857 142857+. When the fraction is converted to *Millennial* numbers, it becomes 15/6, which produces 3.2U72U72U7+.

The product of the fraction continues to repeat the same series of numbers over and over in both languages; however, in *Millennial Math*, the product of the fraction rolls over every three places rather than every six in base 10. The double of this number is 5.U72U72U72+, and one half is 1.72U72U72U+. The same series, in a different order, defines the decimal notation of each.

Further study of 0.2U7 reveals that, when multiplied by six, it produces 0.WWW, and if 0.2U7, 0.U72, and 0.72U are added together, the result is again 0.WWW. Moreover, 0.2U7 multiplied by three produces 0.5C9, a series that also defines its multiplication by four (0.95C) and by five (0.C95).

Returning to base-10, we find that this result is actually a function of the ancient fraction itself, which is a part of its magic, *i.e.*, 0.142857 x 2 = 0.285714, x 3 = 0.428571, x 4 = 0.571428, x 5 = 0.714285, x 6 = 0.857142, x 7 = 0.999999.

After Archimedes, mathematicians, and geometers struggled for hundreds of years with increasingly complex polygons, taking shorter and shorter tangents upon the outside of curves, striving always to find the perfect ratio of two numbers to terminate the equation. However, it required the use of trigonometric functions and logarithms to help several different individuals to identify the fraction 355/113 as producing correctly the first six digits of *Pi*.

The fraction 355/113 reduces to a value of 3.14159 29203, or one slightly higher than true *Pi*, which is 3.1415926. When converted to *Millennial* numbers, the fraction 153/61 yields 3.2U3W5W0 2U3W5W0+. Just as the original fraction 355/113 produced *Pi* accurately to the first six decimal places, the same ratio in *Millennial Math* results in the first five places.

Further extensions of the *Millennial* value of *Pi* can be determined by using the inverse convergents of a continued fraction created in 1767 by Johann Lambert (1728-1777) to prove the irrationality of *Pi*.[26] Following the fraction 355/113 are others of increasing complexity. For example, the fraction 80143857/25510582 can be converted to US5X4W1/1N4U295, which produces 3.2U3W58NNN, or the first nine places of *Pi*.

Unable to perform the higher mathematics required to derive *Pi* directly by continuing equations, I was able to solve several longer Lambert fractions by long division using the hand calculating tables. The first 20 places appear to be 3.2U3W5 8NNN4 830NC 31317; however, the possibility of error increases by the size of the calculations.

The fact that N (which in *Millennial* math occupies the same half way place as five in a base-10 system) repeats itself at the 7th, 8th, and 9th places offers the intriguing likelihood that this particular expression may be an effective rounding off of *Pi*.

In base-10 *Pi*, a number does not repeat itself three times until the 153rd place (1,1,1). If base-10 *Pi* had rounded off as 3.141592555, it is less likely that the same degree of obsession with carrying it further would have prevailed over the centuries.

[26] Beckman, Petr, op. cit., p. 170.

Since *Pi* is a product of random processes, we can see that after a certain point the value of increasing the number of places beyond the decimal diminishes into mathematical noise. The value of *Pi* has now been calculated to five trillion places.

Analyzing very long strings of *Pi* reveals that the various numbers are randomly distributed. For example, if we count the different numbers in an expression of *Pi* to a million places, we will find approximately 100,000 ones, 100,000 twos, etc.

The number N in *Millennial* numbers is the mean of all of the random numbers expressed in the extension of *Pi* into infinity; therefore, it would appear logical that the *Millennial* expression of *Pi*, 3.2U3W58NNN, represents a highly practical value for most, if not all calculations.

The Golden Proportion (*Phi*)

Phi is a marvelous representation of the internal harmony of every number, but, exactly what kind of number is it, and how does it work?

One way of seeing the Golden Proportion (or Ratio) is as a rectangle, whose sides have a length-to-width ratio equal to the Golden Proportion.

If we then imagine that the long side is the short side of another golden rectangle, we can begin to build adjacent rectangles in an endless fashion. These rectangles then define a continuous "golden" or logarithmic spiral, which we can see demonstrated in nature in the spiral galaxies, such as our Milky Way, or in a sea shell. Whenever there is natural growth according to a geometric progression, the result is a logarithmic spiral.[27] (Figure 20)

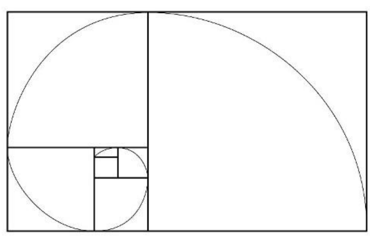

Figure 20

[27] Maor, Eli, *e: The Story of a Number*, (Princeton University Press, 1998). Another

Another way of building a logarithmic spiral is to start with a right-angle triangle with sides of one, one and the square root of two. If we then construct another right-angle triangle, using the hypotenuse of the square root of two as the base and continuing with a side of one, the next hypotenuse will be equal to the square root of three. If we continue to construct triangles in this manner, the result will be another logarithmic spiral that demonstrates the square roots of all numbers between two and 17. (Figure 21)

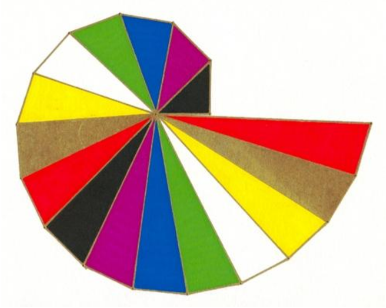

Figure 21

From this we can see the beauty and orderliness of the logarithmic spiral and can compare it to the simple circle, which is itself a logarithmic spiral, but with a zero rate of growth.

The actual calculation of the Golden Proportion in *Millennial Math* relies on the same rules and formulas as in base 10 (*Phi* = (1+square root5)/2). Thus, if we first calculate the *Millennial* square root of five, or square root4 to be 2.3S5XW36, add one and divide by two, the result is the Golden Proportion, 1.7X36679N. Or, we can rely on the Fibonacci series and divide the 28th number by the 27th (6CN94/UC763) to arrive at the same result.

The *Millennial* Golden Proportion squared is 2.7X36679N, and its square root is 1.U4831U587. The decimal extension is identical for both the proportion and its square, but interestingly, like *Millennial Pi*, it too "rounds off" with N. Thus, we can see that the Golden Proportion operates in *Millennial Math* with the same magic as in base 10.

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wonderful book in the same tradition as Beckman's work on *Pi* and Maor's work on *e* is Mario Livio's *The Golden Ratio*, op. cit.

Prime numbers are those that can be equally divided only by one and by themselves, without leaving a remainder. Prime numbers are seminal numbers, and all other numbers are the multiples or progeny of prime numbers. Prime numbers appear to fall at random and without predictability, and their square roots are always irrational.

Efforts to determine a method of predicting prime numbers have been just as obsessive as those involved in the computation of *Pi*.

Eratosthenes of Cyrene (ca. 276 B.C.E. - ca. 195 B.C.E.) was the brilliant librarian of the Ptolemaic library of Alexandria. In addition to accurately calculating the circumference of the earth and the distance to the sun, he designed a sieve method for determining prime numbers in which we can multiply numbers in a progressive way to eliminate non prime numbers.

Table 5 consists of base-10 numbers in which curved parenthesis are placed around each prime number as it is encountered. The remaining numbers that are the product of the multiplication of prime numbers fall through the sieve as they are used. One, with a square bracket, represents unity, and, since it can be divided into all numbers, is not considered to be prime.

[1]	(2)	(3)	4	(5)	6	(7)	8	9	10
(11)	12	(13)	14	15	16	(17)	18	(19)	20
21	22	(23)	24	25	26	27	28	(29)	30
(31)	32	33	34	35	36	(37)	38	39	40
(41)	42	(43)	44	45	46	(47)	48	49	50
51	52	(53)	54	55	56	57	58	(59)	60
(61)	62	63	64	65	66	(67)	68	69	70
(71)	72	(73)	74	75	76	77	78	(79)	80
81	82	(83)	84	85	86	87	88	(89)	90
91	92	93	94	95	96	(97)	98	99	100

Table 5

As a further test of the utility of *Millennial Math*, we can construct a sieve through which to sift out its non prime numbers. (Table 6)

Upon comparing the two sieves, the same numbers are found to be prime, and the same numbers fall through

[1]	(2)	(3)	U	(4)	5	(6)	N	7	8	(9)	S	(C)	X	W	10
(11)	12	(13)	1U	14	15	(16)	1N	17	18	19	1S	(1C)	1X	(1W)	20
21	22	23	2U	(24)	25	26	2N	(27)	28	(29)	2S	2C	2X	(2W)	30
31	32	33	3U	(34)	35	36	3N	37	38	(39)	3S	(3C)	3X	3W	U0
U1	U2	(U3)	UU	U4	U5	(U6)	UN	(U7)	U8	U9	US	UC	UX	(UW)	40
41	42	(43)	4U	44	45	46	4N	(47)	48	49	4S	4C	4X	4W	50
(51)	52	53	5U	(54)	55	(56)	5N	57	58	(59)	5S	(5C)	5X	5W	60
(61)	62	63	6U	64	65	66	6N	67	68	69	6S	6C	6X	(6W)	NO
N1	N2	(N3)	NU	N4	N5	N6	NN	N7	N8	(N9)	NS	NC	NX	NW	70
71	72	73	7U	(74)	75	(76)	7N	77	78	79	7S	(7C)	7X	7W	80
81	82	(83)	8U	84	85	(86)	8N	87	88	89	8S	(8C)	8X	8W	90
91	92	(93)	9U	(94)	95	96	9N	97	98	99	9S	9C	9X	(9W)	S0
(S1)	S2	S3	SU	(S4)	S5	(S6)	SN	S7	S8	S9	SS	SC	SX	SW	C0
C1	C2	(C3)	CU	C4	C5	C6	CN	C7	C8	C9	CS	CC	CX	(CW)	X0
X1	X2	(X3)	XU	X4	X5	X6	XN	(X7)	X8	X9	XS	XC	XX	(XW)	W0
(W1)	W2	W3	WU	W4	W5	W6	WN	W7	W8	(W9)	WS	WC	WX	WW	100

Table 6

the sieve. Undoubtedly, this will hold true to infinity.

A Small Matter of *e*

A question written around 1700 B.C.E. on a clay tablet later found in Iraq asks, “How long will it take for a sum of money to double if invested at 20 percent interest compounded annually?” Since the sum increases by 20 percent each year, it grows by a factor of 1.2, and we can use modern algebra to express the problem as $1.2^x = 2$, in which x equals the number of years, to determine the correct answer of 3.8018, or three years, nine months, and 18 days. Using the sexagesimal (60-base) system of the ancients, the equation was expressed as 3 + 47/602 + 20/603, which produces a close answer of 3.7870.[28]

With the advent of the modern banking system in the Seventeenth and Eighteenth Centuries, bankers began to notice that there was a limit reached in which the number of times that one compounded a certain amount of interest no longer made a difference in the result.

If one dollar is lent out at 100 percent interest, compounded once annually, the result at the end of a year would be two dollars. Compounded 10 times during the year, the result is 2.59374; if we compound it 1,000,000 times, the result is only slightly more, 2.718281828. However, if we compound it 10,000,000, or even a trillion times, the answer will remain 2.718281828, which is the limit of the ratio of change, or the derivative. This small number, 2.718281828, is known as *e*.

Less mundane than compound interest rates was the need in the Age of Discovery to calculate the paths of the heavenly bodies that do not move at a constant rate. Since the path of the planets is an ellipse, the planets speed up as they approach their perihelion near the sun, and they slow down as they swing out to their aphelion.

The need to calculate such matters in a fluid or continuous manner led to the invention of the differential and integral calculus,

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[28] The background in this section was primarily drawn from Maor, Eli, *e: The Story of a Number*, op. cit.

or simply calculus, by Isaac Newton and Gottfried Wilhelm Leibniz (1646-1716) in the Seventeenth Century.

What Newton did was to provide a general procedure for finding the rate of change of practically any function. Thus, the assumption of continuity is the essence of calculus, and the ability to calculate continuous change is its primary value.

Modern science has identified numerous phenomena in which the rate of change of something is proportional to the thing itself. Among the most well-known examples are the rate of decay, or half-life of a radioactive substance and its radioactivity, which is proportional to its mass, and the propagation of sound waves, in which the intensity is proportional to the distance traveled.

Since the limit of these changes is equal to *e*, the number becomes the natural or exponential function used as the base for logarithms in higher mathematics. Or, since the derivative of an exponential function is proportional to the function itself, if *e* is chosen as the base, the exponential function is equal to its own derivative.

A final test of *Millennial* numbers is to derive the *Millennial* value for *e*. Based on the binomial formula, one method of deriving *e* is Newton's continuing equation: $e = 2+1/2!+1/3!+1/4!+1/5!+. . . .$ The symbol "!" means that the number preceding it is factored, such as 3! = (1x2x3) = 6.

The simplicity of this equation meant that it was one of the few in higher mathematics I was able to solve. Working out this equation by hand, I found the value of *e* in *Millennial Math* to be 2.96X141526, a result later confirmed by the computer calculator.

As I was completing this section, I wondered if *Millennial e* would repeat its proportions in the same manner as in base-<u>10</u> (<u>2.718281828</u>). Since the electronic hexadecimal calculating program only displayed <u>nine</u> places beyond the decimal, I spent three days and a tablet of paper using my old familiar calculating tables in an attempt to work out *e* to <u>20</u> places.

Given the great possibility of error, the answer appears to be 2.96X14 1526W 1961S 605U0. Thus, it does not appear that the proportion repeats itself in *Millennial Math* as it does in base 10.

Another way to look at *e*, is to see it as the billionth power of 1.000000001 in every numbering system. I first encountered this one day when my computer calculating program wasn't properly operating, and I wanted to determine the first four powers of *e*.

Finding myself frustrated, and noticing that the square and square root functions were still operating, I began to idly reduce the successive square roots of *e*. As the roots slowly worked their way down to one, I noticed in both base 10 or 16 that all numbers will reduce through different variations until they all arrive at 1.000000002 and then 1.000000001 before achieving unity at one.

When I began to successively square 1.000000001 in *Millennial* numbers, I saw that the process reversed itself, progressing in an orderly manner, and that it achieved the value of *e*, correct to the first six decimal places, at its 36th or 2U'd operation. I attempted the same experiment with base-10, and found that the same result did not occur.

Wondering just how many times 1.000000001 had been raised in *Millennial* numbers, or what was the exponent to produce *e*, I made a guess, raised 1.000000001 to the billionth power and discovered that the result was *e*.

Now more than curious, I repeated the experiment with base-10, and found that 1.000000001 to the billionth power produced *e* accurately to the first five places. Next, trying bases-2, 4, 8, 10 and 12 produced the same result, which follows from the very nature of *e*.[29]

However, an entirely different discovery revealed itself when I began to successively square 1.000000001, depending upon the bases:

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[29] Eli Maor in reviewing this manuscript graciously pointed out that *e* as the billionth power of 1.000000001 in every numbering system simply follows from the nature of *e*; however, arriving at it by the successive squaring by multiples of nine only works in base 2 and its powers, 4, 8, and 16, etc.

In base-2, the value of *e* is 10.101110000, which results from nine successive squaring.

In base-4, the value of *e* is 2.231332013, which results from 18 successive squaring.

In base-8, the value of e is 2.557605213, which results from 27 successive squaring.

In base-10, the value of e is 2.718281828; however, 30 successive squares leads to an inaccurate result of 2.926309006.

In base-12, the value of e is 2.87523606A; however successive squaring, like base-10, does not come close, with 32 operations leading to 2.370421463.

The pattern appears to be that in base-2, it takes nine operations of successive squaring to closely produce the correct value of e. In base-4, it takes 18; in base-8, it takes 27; and in base-16, or *Millennial* numbers, it takes 36 operations. These are the 1st, 2nd, 3rd, and 4th multiples of nine.

Thus, while 1.000000001 to the billionth power will always produce a close value for *e* in all of numbering systems, successive squaring of 1.000000001 only leads to exact *e*, in bases 2, 4, 8, and 16, all being either two or the powers of two.

In a base-32 language, 1.000000001, successively squared 45 (5x9) times should produce the value of *e*, as should successive squaring 54 (6x9) times in base-64.

Elemental Numbers

The ancient magical fraction 22/7 converted to *Millennial* numbers produces an approximate value of 3.2U72U7 for *Pi*, and the division of 0.2U7 by two reveals the elegant little number, 0.12UN.

Over the years, as I performed calculations in *Millennial Math* using these numbers, I occasionally noticed another small number, 0.0S3, kept appearing. I also found that three times 0.0S3 equaled 0.2U7.

If we look at these decimal numbers, such as 0.0S3, 0.12UN, and 0.2U7, we can determine they are all multiples of an even smaller base number 0.010U. For example, 0.0S3 results from 12 times 0.010U.

Comparing these *Millennial* numbers to their base-10 equivalents, we find the result to be far more complicated and much less interesting. For example, 0.2U7 converts to 0.0714285, a third of which (0.0S3) is 0.947619, and the equivalent of 0.010U is 0.00396825. Most telling, the elegant number 0.12UN is the same as the very boring 0.03571425.

While it is true that mathematical calculations can take place in every base language, we can readily see that a hexadecimal language produces a more economical expression of fractional numbers than base 10, and that Millennial numbers are far more elegant than ASCII numbers.

Perhaps we can call the little number, 0.010U, a Pit, and the 0.12UN, a Pyte. We can see them as basic elements of Millennial numbers.

The Beauty and Harmony of Millennial Numbers

A hexadecimal numbering system based on the insertion of special symbols for the powers of two allows for the identification of an internal set of fractional numbers which provide elegant building blocks for all mathematical calculations, including those involving Pi, Phi, and e.

Overall, the Millennial system provides a more logical numbering system than either base-10 or the highly artificial ASCII system. It also provides orderliness and a more economical processing of the very large numbers involved in measuring matter found at the subatomic level and exploring the outer limits of the universe.

Finally, Millennial Math provides both beauty and harmony in working with the mathematics we have discovered and created to describe the universe within which we live.

AFTERWORD

We have studied the mysteries of physics, geometry, and mathematics we inherited from the ancients and which continue to drive our modern human society, and we have made observations in each discipline that, hopefully, may be of some small value in their evolution.

It is unlikely we are alone in the universe. It is much more likely we are simply watched by others who are interested in our progress and concerned about the diseases of deception, hatred, and violence that infect us, individually and collectively.

It is doubtful we will ever be able to fly very far from our nest until we learn to live in peace and we come to discover the promises of the future.

Equally certain, we will never achieve the knowledge, power, and wisdom to travel to any significant destination in the universe unless every child on the planet, irrespective of national origin or personal circumstance, has equal access to nutrition, health care, and education.

Then, we will finally achieve the power to spin through the thin veil dividing us from the related dimensions.

Then, this tiny nest we call Earth will become too small, and our children will fly off beyond our universe and backward and forward through time to visit our past and future.

Our children will become the Watchers, and they will tell the story of how we finally united our minds in a powerful signal of discovery and freedom.

We are Mindkind on Earth. This is our story. How shall it end?

Appendix: Time Travel To Ancient Math & Physics

THE BEGINNING

This book is for those who, like myself, are fascinated with our ancient civilizations and who want to know more about their knowledge and the tools they used. We are fortunate to live at a time when sciences, such as archeology, geology, paleontology, biology, and linguistics are providing reliable clues as to the nature and character of our past existence.

Commencing with the Third Millennium B.C.E., or about the time of the Fourth Dynasty which completed the Giza pyramids, a great deal is known about the more advanced Egyptian and Sumerian civilizations of the time from the records they kept. However, as we travel further back in time, we have to rely on the stones and artifacts left behind in our attempt to understand the nature of these more distant civilizations.

Frequently, however, when we visit the history shelves of our local library or bookstore, we fail to find reliable information about our most ancient civilizations and, all too often, we are confronted with quackery and pseudoscience. Separating the wheat from the chaff was a part of this effort, and the footnotes reflect the best information now available.

From everything we find, it appears the most ancient civilizations worshiped life and motherhood, and they flourished in peace and harmony. It also seems their knowledge may have been more profound than the better known civilizations that followed.

It may have been that the ancient manner of thought was entirely different from today. Most likely, the ancients shared in a collective consciousness of their group, which was unified in the worship of Mother Goddess.

We will rely on the device of time travel to study these ancient civilizations, and we will bounce back into the distant past to see how our universe was created. We will also rebound into the future to see what it may hold. Once again, science provides valuable clues in making predictions of earthquakes, colliding asteroids, and global warming, and it helps us to anticipate and prepare for these dangers.

We can also call upon the wisdom of ancient civilizations to help us prepare for the more immediate threats of disease, poverty, hunger, ignorance, and violence. This, perhaps, is what we should be seeking when we study the distant past. How did they learn so much and how were they able to live in peace?

OUR ANCIENT CIVILIZATION

Writing in 1895, H. G. Wells (1866-1946) imagined *The Time Machine* as a sort of open bicycle frame on which the time traveler was able to ride forward thousands of years into the future—which he did for eight days of romance and adventure, to near the end of Earth's life—before reversing the levers and returning. In the end, the time traveler left on another journey from which he never returned.

Let us now imagine not a time-travel machine, but rather let us use our mental ability to "virtually" detach ourselves from our gravitational constraints, remaining in the constant electromagnetic flux that surrounds and permeates our universe, and to spin into another stream of time, with its own speed of light, flowing past just beyond the reach of our sensory perception.

First, we must add energy to accelerate our existence in order to skip forward in time about 65 million years to a reference point from which we will rebound, beyond now, back an equal amount of time into the past we want to visit.

We can only guess what the future might be like, but, from the records written in the rocks of the earth, we can reconstruct what it was like in the past. Particularly, let us imagine we have the ability to go precisely to where the earth will be or was at any moment of its life, relative to the electromagnetic moment of now and to "see" what there will be and what there was to be seen.

We must first accept that the earth has been spinning in orbit around the sun for several billions of years as it has slowly cooled, and that its crust is as thin, relatively, as the shell of a bird's egg.

The interior of the earth consists of several layers of molten rock surrounding a yolk of iron and the surface is slightly flat at the poles. If we perceive the earth as rolling on its side or equator, we can see it as a massive flywheel spinning around its heavy spherical core with an incredible amount of potential energy as it rolls around the sun.

The molten mass of our earth varies little in either its spin or its orbit in relation to the sun; however, the relatively thin crust floats around on the molten magma like ice on water. What we perceive as solid land migrates about, and any particular place may be found at various points upon the surface depending on the time of our visit.

We can imagine that the axle poles of the planet are the needle of a sewing machine, and the crust is a spherical piece of cloth. As the needle operates up and down, the cloth is drawn across the poles and around the sphere. However, it is the cloth, not the needle that is moving across the sewing surface; relative to the needle, the sewing machine never moves.

As the earth spins around an axle through its poles, the axle tips wobble about in a circle like a child's toy top or a gyroscope. Relative to the twelve constellations of the zodiac, it takes 25,776 years for the axle to complete one complete gyration, causing the sun to rise each year on the spring equinox at a place slightly behind where it was the year before.

This "precession" of the equinoxes is very slow and it takes 2,148 years for the sun to "back" into each new constellation.

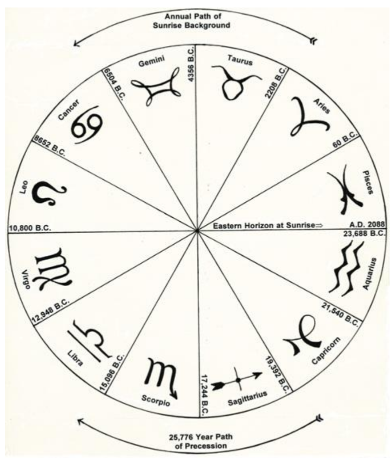

Illustration 1

At present, we are just leaving Pisces and preparing to enter the Age of Aquarius. (Illustration 1)[30]

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[30] Since the twelve constellations are not distributed uniformly around the zodiacal

Now equipped with the imaginary means to time travel and with a chronometer tied to the movement of the heavens, let us travel back a ways to learn about our ancient civilization, before we attempt to look further back and to take a look at our future

A Time of Fire and Death

With our ability to time-trip under control, we can rebound from beyond tomorrow, arcing back across an equal number of years into the past, to the day we have targeted for our first visit to yesteryear, near noon on a warm and clear summer day in the northern hemisphere about 65 million years ago.

The continents are not in the same relationship on the earth's crust as they are today, drifting about as they always have; however, we can still relate North and Central America to the Atlantic and Pacific oceans.

It was the age of the great dinosaurs, who had ruled the earth for millions of years, patiently eating vegetation and occasionally being eaten by their cousins who had developed a taste for meat.

Here and there could be seen tiny, shrew-like creatures, who had evolved into the first mammals, warm-blooded and just a tad bit smarter than their reptilian ancestors. Perhaps one of these small mammals looked up at the brightening light in the sky in wonder, just before a gigantic chunk of rock and ice collided with the earth.

Appearing to come out of the sun, a huge rock the size of Mt. Everest slammed down in the Caribbean Sea just off the Mexican Yucatan peninsula, sending shock waves through and around the earth that focused and disrupted the crust on the opposite side of the globe in India. The rock was pulverized by the impact and its dust, rich in the rare metal iridium, rose into the atmosphere and settled

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circle, and it is difficult to determine the moment when the spring equinox on March 20th moves from one to the next, there are differences of opinion regarding the advent of the Age of Aquarius. Figure 1 is based upon Sitchin, Zecharia, *When Time Began,* (Avon Books, 1993), p. 26.

out over time leaving a layer of clay on the surface all over the world.[31]

A ringside seat in the sky might have provided the only safe viewing platform, as all life on Earth was immediately put at risk. The ocean impact created megatsunamis, which were followed by an intense heat as the ejected debris reentered the atmosphere. Fire around the globe consumed the vegetation and, as a great cloud of dust and soot blocked the rays of the sun, the earth was plunged into a deep freeze.

Then, as the dust was cleared by a sulfuric acid rain, Earth entered a "greenhouse" phase in which temperatures were raised for about 500,000 years. Life was not only hard, it was nigh impossible, and the age of the dinosaur ended, along with much of the life on Earth, but, here and there, the tiny mammals were able to survive and to thrive, feasting on the carrion and detritus that remained.

First Ancestors

If we continue our rebound forward in time, bouncing in the direction of now, we can skip about 60 million years and time our next arrival to about five million years ago. The continent of Africa, which had been slowly drifting north, had rammed into Europe at Gibraltar about seven million years earlier shutting the Mediterranean Sea off from the Atlantic Ocean.

The "sea level" of the Mediterranean dropped as it slowly dried up, causing the Nile River to cut a deep channel similar to the Grand Canyon as it flowed north. Then, suddenly, the Atlantic Ocean broke through the Strait of Gibraltar and flooded the Mediterranean basin to the depth of a mile within a single human lifetime.[32]

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[31] Gribbin, John and Mary Gribbin, *Fire on Earth: How Asteroid and Comet Collisions Have Shaped Human History—And What Dangers Lie Ahead,* (St. Martin's Griffin, 1996).

[32] Ryan, William B. F. and Walter C. Pitman, III, *Noah's Flood: The New Scientific Discoveries About The Event That Changed History,* (Simon & Schuster, 1998), p. 88.

The mammals had been successful during these 60 million years, and in Africa we can find a concentration of related mammals known as primates. One of these is the mother of all of us, a relative of the ape and chimpanzee, who began to distinguish herself by the ability to walk upright, the use of stone tools and a language she used to communicate her learned knowledge.

Our upright stance allowed for more efficient thermoregulation in that bipeds only expose seven percent of their body surfaces to the noontime sun whereas quadrupeds expose at least 20 percent at all times. This allows us to lose heat 33 percent faster than quadrupeds. In the same way, our loss of hair allowed for more efficient sweating and evaporation, while retaining hair only on our heads and shoulders to protect from the most direct overhead radiation.[33]

Whether we got used to standing up for long periods of time in an awkward position, or we are descended from aquatic apes who developed supple spines from earning a living in the lakes, we began to evolve into several different related families of humans, all of whom had knowledge of the use of tools, shelter, clothing, fire, and language.

A Time of Ice

Again bobbing forward across the ripples of time, we can select a date about 100,000 years ago and see what was happening. Zeroing in on the North Pole, one of the first things we might notice is that there is more ice in the northern hemisphere than there was during our last visit.

An ice age had commenced about 15,000 years earlier, or 115,000 years ago, when for whatever reason, the snow stopped melting during summers and accumulated in great rivers of ice called glaciers. As the glaciers moved, inexorably, down river valleys toward the seas they compressed and carved the land beneath them. From the remains, we can see where they used to be.

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[33] Reader, John, *Africa: A Biography Of The Continent,* (Alfred A. Knopf), p. 87.

Although we perceive the Ice Age as having been a rather cold and dismal time, and we can picture the discomfort of Neanderthals huddled around small fires in drafty northern caves, such a view is parochial in that large areas of the southern hemisphere were quite pleasant for long periods of time. In fact, that might be the normal situation on Earth, and we may only be living in a short interlude before the price of real estate begins to drop in the north, and we again migrate home to the south.

Living 100,000 years ago were three species of proto humans, or three divergent types of the same original family. In Africa, black woman and her family had lived for millions of years, and scientists can now tell from DNA testing that we are all related to one woman and her relatives who lived in Africa about 140,000 years ago. Upon our arrival in time travel, 100,000 years ago, she and her extended family continued to live throughout the African continent.

To the east, along an arc from the Indonesia islands onto the mainland of Asia lived another group of cousins known to us as Java Man (*Denisova hominin*), and his wife and family. And, in Asia Minor and across Europe lived perhaps the most prosperous relative in the family, the Neanderthals (*Homo neanderthalensis*), who had succeeded in staying alive during the harsh cold weather through the use of fire and animal furs for warmth.

Ours was already an ancient civilization making use of science. Our ancestor, *Homo erectus* first began mining ocher (a red oxide of iron) in South Africa at least 350,000 years ago for use as symbolic body paint, or perhaps as protection from insects and the sun.

Evidence of the spread of the ocher mining industry can be found from England, France, Czechoslovakia, and India, to Australia. Heating may have been used to change the color of ocher, which later may have led to the heating of flints, the development of pottery, and the smelting of metals.

Evidence of the early use of symbolic language by *Homo erectus* was discovered in 1969 at a Lower Paleolithic site (Bilzingsleben) near Halle in former East Germany. Among a number of artifacts dating from 250,000 to 350,000 years ago was four animal bones bearing unmistakable and deliberate etchings, including an elephant tibia clearly marked with seven and 14 straight lines and another bone with five double lines.

Perhaps even more exciting was the discovery in 1981 of the earliest known carved, human-shaped stone figurine near Berekhat Ram in the Golan Heights. The figurine was found in association with a large number of stone artifacts including scrapers and burins demonstrating a high level of technical competence between two flowing layers of volcanic basalt reliably dated at 800,000 and 233,000 years ago.

Evidence of *Homo erectus* completely disappears from the fossil record around 200,000 years ago being replaced approximately 130,000 to 100,000 years ago by the first remains of our own species, *Homo sapiens* (Latin for "wise man" or "knowing man").

In our appearance, we had grown taller and more slender; our chins jutted forward and our faces were shorter and more tucked under our skulls. We had higher foreheads, without brow ridges, and our brain cavities had expanded to between 1,200 and 1,700 cc. These individuals were anatomically indistinguishable from modern humans.[34]

Though we often credit ourselves with the discoveries of language, art, and science, the most recent evidence demonstrates that our ancestors were also capable of abstract thought and creative endeavors.

A hundred thousand years ago, we had already been engaged in tool making for more than a million years, and the stone hand-ax, our most characteristic product, had become standardized throughout Africa, Europe, and much of Asia. Such conformity could only result from a widespread learned ability to first imagine what the resulting ax should look like before it was knapped from a cobble of stone.

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[34] Reader, John, op. cit.

The Birth of Humanity

Bobbing forward another 50,000 years, we can note upon our arrival that the earth's crust has continued to wander about under the North Pole. Commencing around 91,600 B.C.E., the North Pole migrated from the northwest tip of North America to a location just off the coast of Sweden. It was stable there until about 50,600 B.C.E., when it again began to migrate, this time in the direction of the Hudson Bay, where it remained until about 9600 B.C.E., when the crust slipped to its current location.[35]

Relative to the sun, the earth revolves in a stable orbit on the ecliptic plane, and we can reliably pinpoint its axis poles in relation to the sun; however, we cannot be sure of any particular location on its surface in relation to the poles.

In addition to plate tectonics (in which the crustal plates grind against each other in an endless cycle of destruction and creation), it is possible that the entire crust, independent of the equator and poles, may slowly shift up to 40 degrees from time to time.[36]

The movement of the crust, relative to the molten mass, may result in a migration of the poles back and forth and the equator up and down. Such shifts would cause major changes in the climate for the areas of the earth where the movement is most dramatic. Areas can change from arctic, to temperate, to equatorial and back again.[37]

A theory supporting migration of the poles was first advanced more than a hundred years ago by the Swedish paleontologist,

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[35] Hapgood, Charles H., *Path of the Pole* (Chilton Books, 1970) and (Adventures Unlimited Press, 1999); Flem-Ath, Rand and Rose Flem-Ath, *When The Sky Fell: In Search of Atlantis* (St Martin's Press, 1995).

[36] The crustal movement is different that the shifting of the magnetic poles, which are also in constant movement due to a normal oscillation of the earth's magnetic field. According to Joe Stoner, a paleomagnetist at Oregon State University, the north magnetic pole has moved 685 miles from Arctic Canada toward Siberia in just the past century, and the movement appears to be accelerating.

[37] Hapgood, Charles H., *Earth's Shifting Crust: A Key to Some Basic Problems of Earth Science,* (Pantheon Books, 1958).

Professor A. G. Nathorst. He postulated that the movement could occur over very long periods of time caused by geologic processes such as the raising of mountain ranges causing "one-sided" effects on the earth's axis of rotation. He thought that over millions of years, the poles may have moved as much as 20 degrees of latitude along a line between Japan and Greenland.

The movement would place ancient Bavaria at the same latitude as Algeria is now and would explain the existence of palm trees there in the fossil record. Evidence from multiple observations demonstrated that there is a gradual movement in the same direction that could amount to as much as a degree of movement over a period of 360,000 years.[38]

Albert Einstein believed that, "In a polar region there is continual deposition of ice, which is not symmetrically distributed about the pole. The earth's rotation acts on these unsymmetrically deposited masses, and produces centrifugal momentum that is transmitted to the rigid crust of the earth. The constantly increasing centrifugal momentum produced in this way will, when it has reached a certain point, produce a movement of the earth's crust over the rest of the earth's body. . ."[39]

On this visit we find that by about 50,000 years ago, our society of Homo sapiens had begun to spin outward in every direction, slightly mingling with and completely replacing all previous related groups, resulting in a single species of humans, with different racial body types.

Evidence of the deliberate burial of the remains of humans identifiable as Homo sapiens has been found in Israel at the Qafzeh and Skhul Caves dating from the period 120,000 to 90,000 years ago.

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[38] "Is [the] North Pole Moving Down Toward Chicago?" (Original Source Chicago Herald August 8, 1897, Reproduced with permission: L.L. Dyche, Explorations (Newspaper Clippings Related to Polar Exploration), Vol. 1 & 2. University Archives, Spencer Research Library, University of Kansas Libraries, Lawrence, KS.).

[39] Hapgood, Charles H., op. cit., foreword, p. 1.

In Europe, Neanderthal has been replaced by Cro-Magnon; in Asia, Java man has become Asian Women, modern African Woman has emerged in Africa, and Caucasian Woman first appears, just where and how we are not yet sure.

Perhaps we will never be certain of the exact place and time where human civilization began; however, we find that the origin of language and symbolic logic is far more ancient than has been traditionally believed.

Depending on the school of thought, there are between 5,000 and 10,000 different languages spoken on Earth today. These have been organized most generally into 17 major groups of related languages, one of which is Indo-European. Some linguists identify several of these 17 groups as deriving from a remote ancestral language called Nostratic (Latin: *noster*, "our").

Going even further, a minority of linguists seek to reconstruct a single "Proto-Global" or "Proto-World" language as ancestral to all human languages based upon similarities in common words such as man, woman, child, hole, vulva, finger, and water.

From the moment we struck the first flint and created verbal language to teach the making of fire and tools, our species has been defined by our ability to mentally synapse beyond the limitations of instinct, to acquire and expand knowledge, and to teach the tool of learning and the value of exploration and travel to each new generation. *Then is when we truly became human and took our first steps into the family of Mindkind* .

The Dawn of Civilization

If we set our next time bounce to about 25,000 years ago, we finally arrive at a view of Earth which bears a similarity to its appearance today. The first thing we would notice is that things are not the same as they were 25,000 years earlier, nor as they are today.

The Wisconsin Glaciation, which started about 115,000 years ago, had reached its maximum accumulation about 60,000 years ago, and the North Pole had stabilized in the area of the Hudson Bay about 48,000 years ago.

In Europe, the Wurm Glaciation started about 70,000 years ago in Scandinavia and Scotland and ultimately covered most of Denmark and England and much of Germany. It extended to the east over Poland and Russia and south over all of Switzerland and included much of France, Italy, and Austria.

The Ice Age caused the level of the oceans to drop substantially, up to 90 meters, and much of the shallow coastal areas that are submerged today were once dry land. Around a smaller Mediterranean Sea separating Europe and Africa, we find the first evidence of the arrival of individuals known as Cro-Magnon around 40,000 to 30,000 years ago.

It is not yet clear whether Cro-Magnons assimilated with or replaced Neanderthals, a species which was rapidly disappearing. The latest DNA testing indicates Neanderthals were of a separate linage than Cro-Magnons, although it appears the two species may have intermingled.

Subsequent civilizations, variously known as Old European, Reindeer or Magdalenian, flourished for thousands of years and spread across Europe into Asia. Art from these civilizations can still be seen as wall paintings in caves, some of the entrances to which are now underwater, and as carved images of Mother Goddess.

The earliest art may have been performed by Neanderthals, but recent uranium-thorium dating identifies red-pigment stencils almost 41,000 years old. The most common stencils are of the human hand, but others depict dots, disks and line drawings. Interestingly, most of the hand prints have been proven to be female.

We find evidence of sophisticated flint mining in the Nile Valley as early as 40,000 years ago. It is at about this same time (35,000 years ago) that we find early evidence of counting in 29 notches carved on a baboon's thigh bone which was recovered in the Lebembo Mountains in Africa. Slightly younger is a wolf bone found in Czechoslovakia, which has 55 notches and is 30,000 years old.

A cave near Ulm, Germany sheltered human culture for thousands of years and has provided archeologists with evidence of its longevity. A 40,000-year-old layer reveals an ancient appreciation of art in the forms of a Venus figurine, a flying water bird and a half-human, half-lion figure. A 35,000-year-old layer provided evidence of music in a bird bone flute with five precisely drilled holes, and another ivory flute has been dated to 30,000 years ago.[40]

The Ancient Mariners

Increasingly, there is compelling evidence of the existence of an early maritime civilization prior to historic times. Evidence of this civilization can be found by studying the most ancient maps in existence, maps that were created at a time when Antarctica was still *Terra Australis Incognita*, but which clearly demonstrate that the map makers were aware that Antarctica was a continent and which demonstrate its shape.

The oldest of these maps is one compiled by the Turkish admiral Piri Reis (ca. 1465 - ca. 1555) from earlier maps which shows the northern coast of Antarctica, the western coast of Africa and the eastern coast of South America. The Piri Reis map shows details of Queen Maud Land although modern geological evidence

[40] Maugh, Thomas H. II, "35,000-year-old flute is oldest known musical instrument," *Los Angeles Times*, June 25, 2009.

demonstrates that the area was last free of ice more than 6,000 years ago.[41]

Other old maps compiled from even more ancient sources also showed Antarctica in an ice-free condition. Included is the Oronteus Finaeus (1494-1555) map drawn in 1531, several maps prepared by Gerard Kremer, also known as Mercator, (1512-1594) in 1569, and Philippe Buache (1700-1773) in 1737.

In particular, Buache's map shows Antarctica as divided into several islands, which was not known until a comprehensive seismic survey was carried out in 1958.

These ancient maps suggest that we may have once inhabited the world as a race of mariners and that we mapped the earth's surface with a high degree of accuracy. Such maps were not compiled by landlubbers—they were made for sailors to find their way home across the waterways of the earth using familiar guideposts in the sky for directions.[42]

What remains to tell us of the civilization we once enjoyed? From the map projections, we must have understood spherical trigonometry, and certainly we could not only tell time but could tell time accurately. The ancient observatories located around the rims of the seas, such as Stonehenge, Silbury Hill, and Newgrange (established as early as 3000 B.C.E.), may have served to facilitate navigation.

Most likely, our ancient civilization understood the concept of science, although our technology may have been rudimentary. For example, simple batteries have been found in archeological digs in Iraq, along with ancient manuscripts from India telling how to wire them in sequence.

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[41] Hapgood, Charles H., *Maps of the Ancient Sea Kings* (Chilton Books, 1966) and (Adventures Unlimited Press, 1996).

[42] Hancock, Graham, *Fingerprints of the Gods,* (Crown Publishers, Inc., 1995).

We understood chemistry and the various minerals and ores found in and near Egypt.[43] We knew much about metals, their differences and alloys, and we created an extensive language of words, first identified in ancient Sumerian cuneiform tablets, to describe the smelting processes.

When Did Time Begin?

In the Third Century B.C.E., an Egyptian priest by the name of Manetho compiled a list of kings that still forms the basis on which modern scholars calculate the various dynasties of Egypt. Commencing more than 36,525 years ago, the "gods," such as Ra, Osiris, Isis, and Horus, ruled for the first 13,900 years, followed by the Demigods, Spirits of the Dead, and finally by human pharaohs.

The Egyptian calendar carries a starting date of 49,214 B.C.E.; however, the First Dynasty for which there is a historical basis dates from 3100 B.C.E.

When the Greek historian, Herodotus of Halicarnassus (ca. 484 - ca. 425 B.C.E.), visited Egypt, he reportedly was informed that there had been "four occasions when the sun rose out of his wonted place—twice rising where he now sets, and twice setting where he now rises." This may refer to one-and-one-half cycles of precession totaling 39,000 years.[44] (*See above* Illustration 1).

At the time of the Spanish conquest, the Aztecs believed they lived in the fifth of five "suns" stretching back in time more than 17,141 years. Although the exact period of the Fifth Sun was unknown, it was already thought to be old and that it would end with a great movement of the earth.

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[43] Davidovits, Joseph and Margie Morris, *The Pyramids: An Enigma Solved,* (Dorset Press, 1988).

[44] Hancock, Graham, op. cit., pp. 384-385.

According to the Mayas, who dated their civilization or "long count" from 3113 B.C.E., the Fifth Sun was to end on December 23, 2012.[45] It did not appear to have done so.

Whether we ourselves are the children of God, created by God, or the result of experimentation by aliens from outer space, whether we are the progeny of time trippers from the future who were able to travel to the past with only their scientific knowledge, naked and without tools, or whether we just simply evolved here as a result of our own effort and initiative, it appears that we lived in great peace and harmony with nature and each other for thousands of years.

Migration of the Ancient Mariners

Starting about 17,000 years ago, the Wurm Glaciation began to retreat in earnest—by 13,000 years ago the maximum extent of the Wisconsin Glaciation began to melt, and the sea level was raised by 50 meters.

A recent comparison between ice cores from Antarctica and Greenland shows that both areas experienced a rapid warming, as great as 59 degrees within a 50-year period, at about the same time around 12,500 years ago.[46]

The Ice Age in the northern hemisphere had completely withdrawn by 8000 B.C.E., and by 5000 B.C.E. the sea level was raised by another 40 meters.

Commencing in about 14,500 B.C.E. and lasting for about 2,000 years, there was a great extinction of species on Earth. It has recently been postulated that the extinction may have been caused by the explosion of a massive comet over the North American continent

[45] Sitchin, Zecharia, *The Lost Realms,* (Avon Books, 1990), p. 33; Hancock, Graham, op. cit., pp. 98-101.

[46] "Ice Age Ended Abruptly, New Study Shows," *Los Angeles Times*, October 2, 1998, p. A29.

approximately 12,900 years ago. Immense wildfires may have killed large populations of mammals.[47]

Humanity survived these disasters by migrating.

Although the accepted conservative view is that the Americas were populated by Asians who moved across the Bering Strait during the Ice Age when it was solid land, there is also strong evidence that migration may have occurred because our ancient civilization was seafaring.

Since the rising ocean levels following the Ice Age have covered areas of habitation along the coast, excavations on the Channel Islands off the coast of California have allowed archeologists to postulate that maritime sailors from Asia explored the west coast of America 13,000 years ago.

In addition to the Asians who may have crossed at Beringia, there is evidence that proto-Japanese may have hunted birds and fish along the coast. Delicate barbed arrowheads and broad crescent arrowheads found on the islands are similar to points dating from 16,000 years ago found in Japan.[48]

The most recent DNA evidence establishes a relationship between the settlers of coastal regions from Alaska to Tierra del Fuego more than 10,000 years ago.[49]

Seven thousand years ago, the coast of Southern California was occupied by a technologically sophisticated civilization. Evidence of this culture, consisting of mortars, grinders, weights, and projectile points, has been located offshore and underwater near San Diego.[50]

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[47] Pringle, Heather, *Did a comet wipe out prehistoric Americans?,* NewScientist.com news service, May 22, 2007.

[48] Maugh, Thomas H. II, "Archaeologists find evidence of early maritime explorers," *Los Angeles Times*, March 5, 2011.

[49] Chawkins, Steve, "DNA Ties Together Scattered Peoples," *Los Angeles Times*, September 11, 2006, p. A1.

[50] Marx, Robert F., *The Underwater Dig: An Introduction to Marine Archaeology*, (H. Z. Walck, 1975).

Testing of the skeleton of a female recently found on Santa Rosa Island off the coast of Santa Barbara, California resulted in a radiocarbon date of 13,000 years making it the oldest human remains in North America.[51]

It has been determined that a settlement at Monte Verde in Chile containing stone tools, fire pits, and hide-covered huts can be reliably dated to about 12,500 years ago. More recent carbon dating of seaweed has moved inhabitation back to 14,100 years ago.[52]

South American peanuts have been found on the coast of China at an archeological site dated 3000 B.C.E., and there are a number of similarities between Central American and Chinese cultures. Jade beads are found in the mouths of corpses of both cultures, and both the Shang Dynasty (1525-1027 B.C.E.) and the Olmecs (1300-900 B.C.E.) worshiped big cats without lower jaws.

Wheeled toys, knotted strings, ax-shaped coins, and conical-lidded cylinder pots are found in both cultures, and the Chinese legend of Fu-sang refers to a paradise located beyond the Eastern Sea. Interestingly, there was no millet or rice located in the Americas, indicating that some of the movement of cultures may have been from the Americas toward Asia.[53]

Within the period approximately 12,000 years ago accepted by most archaeologists for the occupation of America, are the distinctive fluted spear points, or Clovis flints, dated to 10,900 to 11,200 years ago, which were first found in New Mexico.[54] These points are

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[51] Polakovic, Gary, "Channel Island Woman's Bones May Rewrite History," *Los Angeles Times*, April 11, 1999, p. 1.

[52] Maugh, Thomas H. II, "Seaweed confirms Monte Verde village in Chile is among oldest in the Americas," *Los Angeles Times*, May 10, 2008.

[53] *Quest For The Past: Amazing Answers To The Riddles of History*, (Reader's Digest, 1984).

[54] More controversial are radiocarbon dates obtained at the Meadowcroft Rockshelter near Pittsburgh, Pennsylvania indicating an occupation as early as 13,000 B.C. Adovasio, J. M., with Jake Page, *The First Americans: In Pursuit of Archaeology's Greatest Mystery,* (Random House, 2002).

different from and less delicate than those found on the Channel Islands and in Japan.

The earliest of these "Clovis" points are also found in the southeast part of North America and they are most similar to artifacts found, not in Asia, but from the Solutrean culture which lived in France and Spain. Both cultures made beveled, crosshatched bone rods, idiosyncratic spear points of mammoth ivory, and triangular stone scrapers.

Support for direct cross-ocean migration to the eastern shores of America has been discovered in an archeological dig near Carson, Virginia. A prehistoric campsite at the "Cactus Hill" site has been firmly dated to be as early as 15,000 B.C.E. and includes primitive stone points. More modern "Clovis" spear points were located in a hearth found to be about 10,900 years old. One theory is that the earlier settlers were proto-Spaniards who may have sailed across the Atlantic as early as 18,000 years ago.[55]

Abandonment of the Clovis-first model of settlement received support with the discovery of a massive cache of artifacts buried under Clovis remains near Austin, Texas. The 16,000 artifacts are at least 15,500 years old and raise new questions about how and when America was settled.[56]

Additional support of an earlier Atlantic crossing was provided by the discovery of a tapered stone blade with a 22,000-year-old mastodon tusk near the mouth of the Chesapeake Bay in 1970. The discovery lends credence to the "Solutrean hypothesis" which holds that Stone Age Europeans paddled along the edge of an ice cap to North America during the last ice age.[57]

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[55] Maugh, Thomas H. II, "New Answers to Old Questions," *Los Angeles Times*, May 4, 2000, p. B2.

[56] ---, "Artifacts upend theory on first North Americans," *Los Angeles Times*, March 26, 2011.

[57] Vastag, Brian, "Radical theory of first Americans places Stone Age Europeans in Delmarva 20,000 years ago," *The Washington Post*, February 29, 2012.

The additional discovery of stone tools from other mid-Atlantic sites are correlated with similar tools found at Solutrean sites in Spain and France. These tools are also believed to be at least 21,000 years old.

The range of the ancient mariners extended into the North Atlantic where evidence of the Maritime Archaic Red-Paint Cultures of western Scandinavia and northwest Europe can be found and carbon-dated in Norway as early as 5500 B.C.E. Operating oceangoing ships and hunting swordfish and marine mammals, they colonized Labrador and New England by 5000 B.C.E., a land which became known as Iarghal (Beyond-the-Sunset).[58]

We don't know how much warning the ancients had, but with our shorelines and settlements awash in the rising oceans, it appears we began to migrate to the Andes in South America, the Nile Valley in Egypt, and elsewhere, where we set about relocating our navigation points in the sky and reorienting our maps.

Trusting in the familiar constellations, we said goodbye to Virgo one morning on the spring equinox around 10,800 B.C.E. as we watched the sun rise for the first time in the House of Leo.

We settled in for a 2,148-year visit and began to carve the lion-shaped Sphinx facing due east and erected a high obelisk between her paws to measure time and location. We laid out the Giza precincts and may have built the bases of the pyramids as observatories to relocate the geodetic navel of the earth and to recalculate our charts of the stars.

With our compasses reoriented, our ancient ancestors found a new pole star to navigate by and steered more often toward the more pleasant northern hemisphere.

Archaeologists have identified the emergence of a farming culture known as the Natufian in a broad area between Jericho, Asia Minor, and the Euphrates around 13,000 years ago. For 1,500 years

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[58] Fell, Barry, *America B.C.* (Pocket Books, 1976), p. 44 and the Bibliography section entitled: *Earliest Voyages and Transatlantic Contacts ca. B.C. 5000-3000*.

during a reversal of Ice Age warming, the Natufians used sickles of carved deer antlers embedded with flakes of flint to harvest the natural stands of native wheat and rye. They also gathered wild barley, lentil, and vetch, and the fruit of the hackberry, plum, pear, and fig tree, as well as the caper bush. However, when the Ice Age again ended and warming resumed, the Natufian culture collapsed.[59]

Obsidian found at archeological sites in southern Greece and identified as having come from the island of Melos provides evidence of travel by boat in the Aegean Sea at the dawn of history around 6500 B.C.E. Here too is evidence that we were engaged in the cultivation of emmer and einkhorn wheat, peas, and vetch, as well as the domestication of sheep and goats.[60]

Soon thereafter, the island of Crete was settled by seagoing immigrants from Anatolia, and the Minoan civilization was founded by 6000 B.C.E. For more than four thousand years, a peaceful society based upon the worship of the Mother Goddess flourished on Crete and the surrounding islands.

Influence of the Mother Goddess civilization extended throughout Europe and as far east as Mesopotamia, and its knowledge was transmitted in the first written language. The language is not known to contain words relating to war and slavery, and its art did not depict violence as a way of life. Its culture not only recognized and emphasized the rights of women, but it involved a high degree of equality in the sharing of wealth.[61]

Emerging evidence from behind the former "Iron Curtain" powerfully demonstrates that the Black Sea was shut off from the Mediterranean at the Bosporus Strait during the Ice Age when the sea level dropped worldwide.

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[59] Ryan, William B.F. and Walter C. Pitman, III, op. cit., p. 173.

[60] Renfrew, Colin, *Archaeology and Language: The Puzzle of Indo-European Origins,* (Cambridge University Press, 1987).

[61] Riane Eisler, *The Chalice & The Blade: Our History, Our Future,* (HarperCollins Publishers, Inc., 1987); Gimbutas, Marija, and J. Marler, Ed., *The Civilisation of the Goddess: The World of Old Europe,* (Thames and Hudson, 1991).

Becoming a large fresh water lake, the Black Sea was the center of a fruitful culture that was destroyed when the rising water of the Mediterranean Sea broke through the Strait approximately 7,500 years ago. The forced migration of the survivors of this culture into China, India, Iraq, Syria, Israel, Egypt, Greece, and Europe gave rise to the spread of the Indo-European language and culture into these areas. It is likely that this event is the historical basis of the Great Flood recorded in the Old Testament.[62]

By 4000 B.C.E., advanced civilizations arose in the Andes, Sumer, the Indus Valley, and in Egypt. From then until now, human society has oriented itself to the land rather than the seas, and has redirected its spiritual worship from life and the Mother Goddess toward violence, death, and the standards of war.

[62] Ryan, William B.F. and Walter C. Pitman, III, op. cit., p. 149.

ANCIENT PHYSICS

We may never know or discover the full extent of the knowledge of physical sciences possessed by the ancients, or recover from its loss, but we can imagine its logical extent from the available archeological record.

From all evidence, it is increasing clear that a learned society existed, which was primarily focused upon a full world view of all the seas and their successful navigation over thousands of years. Evidenced is a sophisticated comprehension of the physical movement of the earth in relation to the heavenly bodies based upon a high order of scientific observation and systematic recording.

We can also see that the ancients were not only mariners but that one of the reasons they sailed was to seek out metals to mine, smelt, and forge into the tools they used to cut stones and timbers used in building observatories, homes and ships.

We are also learning that their understanding of physics involved a high level of chemistry, not only exhibited in metallurgy, but in the mixing of chemical electrolytes to power electric batteries perhaps used in electroplating metals.

It may have been that the ancients' mode or manner of thought was entirely different from that of today. A comparison has been made between the "solar knowledge" of today based upon words and concepts and the "lunar knowledge" of the ancients based upon intuition and the ability to grasp things as a whole.

Differing from the fragmented knowledge of today when no one individual can possibly know everything, the ancients may have shared a "state of heightened consciousness in which they understood some secret of cosmic harmony and its precise vibrations, which enabled them to feel an integral part of the world and nature."[63]

Under this view, ancient individuals were never rugged individualists—he and she were always members of a group and shared in the collective consciousness of the group much like a fish in a school or a bird in a flock. The collective civilization may have been totally unified in the worship of Mother Goddess, a religion in its entirety.

The Loss of Inertia

The core of our ancient civilization survived the last slippage of the earth's crust and comet bombardment, and its cultural knowledge was still intact when the foundations of the pyramids and the Sphinx were reoriented more than 11,000 years ago, and the Nile Valley was colonized.

By the time the pyramids were completed in about 2500 B.C.E. much of the ancient knowledge of physics appears to have still been in practical use as evidenced by the quality of materials and construction used in completing the pyramids and the restoration of other megalithic buildings at that time.

Neither the Egyptian civilization which followed, nor the Sumerian civilization which began at about this time, was ever again so talented. Both civilizations continued to flourish; however, their level of knowledge of the physical processes never returned to where it was in the beginning, although some of the tools of geometry and mathematics survived as useful in a society now oriented to the land, rather than the sea.

Lost was the science of mentally imaging related actions and reactions within the physical world, which was replaced by attribution

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[63] Wilson, Colin, *From Atlantis To The Sphinx: Recovering The Lost Wisdom Of The Ancient World,* (Fromm International Publishing Corporation, 1997), pp. 6-13, 329, 335.

of all observable natural phenomena to the "gods" who resided in the realms of heaven.

Bouncing forward in time several thousand years to a little more than two thousand years ago, we can pick up recorded history in the Fourth Century B.C.E., when Aristotle (384-322 B.C.E.) and other classical Greek scholars used the last remaining tools of mathematics and geometry and the ancient measures they had learned from the Egyptians to simplify, excessively, their understanding of physics.

With their world view limited to the small Mediterranean Sea, and with what little they learned from Alexander's conquest of the East, the Greeks tried to explain what they observed, but they had little understanding of the underlying physical foundations.

Aristotle and the others lost sight of the fact that mass inherently has inertia and naturally moves, unless a force is used to slow it down, and erroneously concluded that mass does not move unless forced to. He and the other Greeks could never understand why mass kept moving, because they had such difficulty getting it going. Along with the later Egyptians, they extended the idea that mass had to be powered by imagining that the "gods" moved the sun, moon, planets and stars around the earth.

While Aristotle could imagine that heavier weights might fall at the same speed as lighter ones in a perfect vacuum, he could not admit the possibility of such a vacuum. Since for him, it did indeed appear that heavier things seemed to fall faster than lighter ones, at least in water, no further explanation was necessary.

Writing a generation earlier than Aristotle, Democritus (460-370 B.C.E.) and others were able to imagine that all mass was ultimately composed of what they called atoms, but the Greeks were unable to differentiate any further than the simple categories of earth, water, fire, and air, and assumed that each had different kinds of atoms.

With their narrow world view, the Greeks were able to explain simply their everyday observations of wood burning and smoke rising, rocks sinking in water, and the heat of the sun, at least for their practical needs and to their satisfaction.

Plato (427-347 B.C.E.) told a story about the difficulty of understanding and explaining the physical processes. In his Allegory of the Cave, humans are depicted as slaves chained in the dark recesses of a cave in which the only thing they see are the shadows cast by unseen fires behind them, made by people holding various objects over their heads.

One slave is released into the real world and observes both its beauty and the nature of the objects, which the slaves have seen only as shadows. Responding to a duty, the slave—now a philosopher—returns to the cave and attempts to explain to the others what the real world outside is like. The others reject what he says and threaten him with death if he continues to disturb their orderly, yet benighted, existence.

Plato concluded that, irrespective of the risk, philosophers have the duty to explore and to offer alternative explanations for observable phenomena.

Aristotle and the other Greeks either forgot or never learned the science of creative thinking. Because they remembered and used only the tools of critical thinking, most of the ancient secrets of physics were lost to human society for more than 2,000 years, along with all that might have been.

Only in the last century have we regained the knowledge to scientifically conceptualize the physical creation of our universe.

The Birth of Matter

In the beginning of our universe, about 12 to 13 ½ billion years ago, according to current theory,[64] there existed only an unlimited dark void into which was born a single spark of light, smaller than a grain of sand. We still hear the echoes of the moment as static on our radios and can see it as "snow" on our television sets.

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[64] Using data obtained from the Hubble space telescope, scientists have lowered the estimated age of the universe from the earlier believed 15 billion years.

We visually imagine the birth as a "big bang," or fireball of pure energy, which almost instantly and incomprehensibly inflated to the size of a basketball, before slowing at several plateaus into a continuous expansion that continues to this day. Thus, our universal Gaia was born; she cried out, and with each respiration, she grew stronger and survived.[65]

The inflation was not quite uniform, and in the chaos, tiny, "quarky" bits of pure energy flashed about, without rest or mass, and began to coalesce in groups of threes into measurable entities, without electric charge, which we know as neutrons. In a quick series of short steps, since a neutron cannot stand to be alone for more than about a minute, the first stable electrical particles came into being.

The neutron, which is without charge, spits out a particle similar to a photon of light, which immediately splits into a neutrino, without mass or electrical charge, and a tiny, negatively charged electron, leaving behind a slightly-reduced, positively-charged proton, about which a captive electron nervously vibrates.

Although the electron (also known as a beta particle) is more than 1,800 times smaller in mass than the proton, its negative charge exactly balances the positive charge of the proton. This family group, consisting of a single neutron that has divided into a proton and electron, makes up an atom of hydrogen, the basic chemical element of the universe.

If we imagine the nucleus of an atom to be the size of a dust particle, the orbiting standing wave of the much smaller electron would represent the outside walls of a huge surrounding building. Thus, what we perceive as mass is mostly nothing at all, surrounded

[65] Gribbin, John and Mary Gribbin, *In the Beginning: After COBE and Before the Big Bang,* (Little Brown and Company, 1993); Spielberg, Nathan and Bryon D. Anderson, *Seven Ideas That Shook the Universe,* (John Wiley & Son, Inc., 1987); Speyer, Edward, *Six Roads From Newton: Great Discoveries in Physics,* (John Wiley & Son, Inc., 1994); and Asimov, Isaac, *Asimov on Physics,* (Avon Books, 1976) were all relied upon in the following essays.

by a perception of solid matter created by clouds of electrons, which are at once both everywhere and nowhere at all.

Neutrons and protons, which join together in increasingly larger nuclei, are bound together by the super glue of the strong nuclear force, the most powerful force in nature. With the slightly weaker force related to the decay of a neutron and the electron's escape, or “beta decay,” the combined great power of the nuclear forces reaches out only a tiny, million-billionth of a meter.

Thus, any two hydrogen atoms, separated or passing by at any greater distance, will not “electromagnetically” notice each other, unless they accidentally bump into one another, “gravitationally,” which they often tend to do, bouncing back and forth about a hundred-billion times a second, at room temperature.

After about 300,000 years of existence, as the universe cooled, the hydrogen atoms began to organize themselves into massive gaseous clouds.

Within these clouds, the lone protons of hydrogen atoms began to marry an eligible neutron to become deuterium, or heavy hydrogen. Then, in a joint wedding, two atoms of deuterium came together in a nucleus of two protons and two neutrons, surrounded by their two electrons, to become a very stable atom of helium.

Soon, these gigantic churning clouds of hydrogen and helium stretched across the expanding “universe,” some extending more than 500,000 light years in diameter, and began to exhibit their collective “gravitational”—as distinct from their nuclear or electromagnetic—attractiveness for each other.

With just a few seeds of lithium and other rare elements, these clouds organized into the first rotating galaxies and began the job of making stars and planets.

While the invisible gravitational “force” exhibited by the combinations of mass into clouds of gas, galaxies, and stars is the weakest of nature, it seems to have the greatest range, with our earth's “gravity” easily “attracting and attracted” by every member of our local solar system, and perhaps well beyond.

One way of estimating just how far the influence of Earth may reach is to imagine a “mini” or little bang or “mini nova,” consisting of the instantaneous release of all the nuclear forces binding all the atoms of the earth, including ourselves, and to see just how far news of the explosion would carry. It is likely that evidence of our former existence would be observable far beyond the Milky Way.

As we imagine the extent of this invisible influence, we can begin to see that all condensations of mass swirl around in their unique places within and as a part of the original, primordial amniotic energy.

All mass, irrespective of size, distorts the area around itself, yet remains attached to and a part of all other mass. This invisible field, which we define as space-time, negatively compresses around organized mass, resisted by the full extent of its positive latent energy, which is substantial, and whose reach carries the message of its power.

However, our blue water Earth is far too forgiving and kind to blow apart, and there's no need to have it explode for us to imagine a different place from which to start. So, let us bounce forward in time to about four and a half to five billion years ago to experience the birth of our sun.

The Mass Generator

In our earlier time travel, we left off at about 300,000 years after the creation of our universe, when the temperature cooled down to about that of the surface of the sun, expansion slowed down to the speed of light, and matter became “positively” uncoupled from the “negative” energy which produced it.

At this time there existed gigantic clouds of hydrogen and helium gases, in a ratio of about three to one, that began to form into the first galaxies of stars. The first generation of stars was far more massive than today and we can see the results in the form of quasars, the most distant and energetic sources of radiation in the universe.

These quasars are the remaining cores of gigantic stars that blew apart in events we call supernovas.

Star Birth

Assuming that the universe began about 12 to 13 ½ billion years ago, we can bounce forward in time to about four-and-a-half to five billion years ago when our Sun was born.

It now appears that star formation may occur as the result of the shock waves caused by a supernova moving through a cloud of dust, hydrogen, helium, and other elements, causing a localized concentration of gases to begin swirling around a common center of gravity.

When the sun first formed from a cloud of these molecular gases, it contracted under the force of its own gravity and began to get hotter in the center from the compression in the same way the temperature within a bicycle tire is elevated as the volume of air is increased. Or, conversely, as an automobile tire becomes heated from being driven over the road, the pressure within the tire increases.

As the temperature approached 15 million degrees centigrade in the core of the sun, it became so hot that a nuclear reaction began to occur in which the electrons were stripped from the hydrogen nuclei to form a plasma of free electrons. Within this plasma, which acts as a gas, two hydrogen nuclei can join together with two neutrons to form a helium nucleus (also known as an alpha particle) releasing a small amount of excess energy (about 0.7 percent), that we perceive as the sun's radiation.

The total mass of the sun is about 330,000 times that of the earth, creating a pressure 300 billion times the pressure of the earth's atmosphere at the surface and compressing a density at the core approximately twelve times that of lead.

Although the sun converts five million metric tons of mass into energy every second, after four-and-a-half billion years of effort, our sun has only consumed about 4 percent of its original stock of hydrogen. However, only 0.7 percent of that 4 percent has actually been lost in the form of radiation, with the balance converted into helium nuclei and retained within the plasma core.

In another five billion years, the sun will have converted enough hydrogen into helium in its core to begin to run short of hydrogen, although there will still be plenty of hydrogen left in its outer layers. When this shortage occurs, the core will begin to shrink and the helium will get hotter. When the compression becomes great enough, the helium itself will begin to "burn," and the sun will begin to swell up into a "red giant," whose circumference will balloon out to near the earth's orbit.

During this expansion phase, three helium nuclei (each with two protons and two neutrons for a total of four) will combine together into atoms of carbon, each with six protons and six neutrons (12).

Because our sun is not large enough, its generation of elements will end here, as it will not have enough mass or internal pressure to move up the scale to produce atoms of greater complexity. When the sun exhausts the helium fuel in its core, it will shrink down to a carbon cinder about as large as the earth. Here it will stabilize as a small white dwarf star, and it will shyly shine for a very long time.

Star Dust

If the sun was twenty-five times larger, its main phase would be much shorter than our sun's projected ten-billion-year lifetime, but the times would be far more interesting.

In these larger stars, hydrogen burning only lasts about seven million years, the helium about 500 thousand years, and the carbon would be burned up in 600 years. In doing so, two carbon (12) nuclei stick together to form magnesium (24), which releases an alpha particle to become neon (20), or ejects two alpha particles to become oxygen (16).

Once a massive star has consumed its carbon, it begins to fuse its neon and oxygen core into atoms of magnesium, phosphorus, sulphur, and silicon. Ultimately two silicone (28) atoms fuse together to form a nuclei of iron (56), the most chemically stable of all energy states.

In these giant stars, following carbon burning, the neon will only last one year, the oxygen six months, and the silicon will fuse into iron in a single day. Any star which is larger than eight times that of the sun will follow the same process; however, the smaller they are, the longer it takes.

Star Death

When the day finally comes when there is but iron in the core of these giant stars, and the iron is so stable that no further nuclear reactions can take place to exert outward pressure against the full weight of the surrounding star, the iron nuclei will merge with the electron plasma into a solid core of neutrons. Within just a second, a ball of iron about the size of the earth collapses into a ball of neutrons about the size of a mountain, consisting of about one part to 24 parts of the total solar mass.

As the outer layers fall inward at about 15 percent of the speed of light and strike the core from every direction, its enormous energy is bounced back producing an enormous shock wave sufficient to blow the star apart.

During the instant of explosion, sufficient energy is produced to fuse elements far heavier than iron, all the way up the ladder of element formation to that of uranium. All of these heavier elements are swept away, along with a massive release of neutrinos, leaving only the core, which becomes a neutron star. In rare cases, where the star is extremely large, its core becomes a black hole from which no light can escape.

As the shock wave of a supernova extends through the star's home galaxy it sets up the conditions for further star formation and seeds it with the elements necessary for life. All of the identifiable matter in the universe is composed of 99 percent hydrogen and helium; the remaining one percent, true star dust, make up planets, like the earth, and its inhabitants, such as ourselves.

The Metes and Bounds of the Universe

About four-and-a-half to five billion years ago, the shock wave of a supernova moving through one of the spiral arms of the Milky Way provided just enough push or compression for a cloud of hydrogen and helium gas, seeded with the dust of previous novas, to collapse into a unique gravitational entity.

As it swirled around its center, the entity formed a saucer shape with a bulge in the middle, which with time and compression began to radiate its excess energy. The bulge became our sun, and across its equatorial plane, the leftover matter began to organize itself into bands of mass separated by clearings, or gaps of space. With the bump and grind of the gravitational dance, these bands of star dust slowly organized themselves into the planets and asteroid belt as we know them.

The Veil of Comets

Out beyond the outermost planet, which was probably Neptune in the beginning, the sun's "gravity" was insufficient to organize planets. The excess mass coalesced into frozen comets, composed of rock and ice, extending the edge of the saucer plate by about 100 AU (one AU equals the distance from the earth to the sun).

This extension is known as the Kuiper Belt and contains at least a billion comets. On a smaller scale, if we imagine that the earth was the size of a button and was one inch from the sun, the Kuiper Belt would be 100 inches, or slightly less than three yards away.[66]

In addition to comets, large icy planetoids range through the Kuiper Belt and likely account for the late planet Pluto, its largest moon, Charon, and some of the moons of the regular planets. Approximately 40 such objects beyond Pluto have been discovered since 1992.

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[66] These relative distances are drawn from John and Mary Gribbin's *In the Beginning*, (op.cit.), except they use candies instead of buttons; they attribute the analogy to Marcus Chown.

In 2003, astronomers discovered a planetoid approximately the same size as Pluto (which was named Sedna, or 2003 VB12), and they first photographed a new "planet" (identified as 2003 UB313 and tentatively named Xena), with a diameter 435 miles larger than Pluto. Xena is almost 10 billion miles from the sun and takes twice as long as Pluto to complete its orbit.

Although larger than Pluto, there was a controversy as to whether Xena should be promoted as the 10th planet or if Pluto should be demoted from being a planet. The issue was resolved on August 24, 2006 when the International Astronomical Union decided that to be a planet, an object must orbit a star, be large enough for its own gravity to pull it into a spherical shape and it must have cleared out the neighborhood around their orbits. Pluto failed to remain a planet since it orbits in the midst of icy debris. It, along with Xena and Sedna, will be known henceforth as a "dwarf planet."

Related to the Kuiper Belt, but organized differently, is the outer Öpik-Oort Cloud, a spherical shell of about a trillion comets, which extends out as far as 100,000 AU. Using the same analogy as above, if the earth was a button one inch from the sun, the Öpik-Oort Cloud would be located a little more than one-and-one-half miles away.

At this distance from the sun, the comets in the cloud are beyond the influence of the planets; however, they can be affected by the gravity of passing stars. Within the outer shell is a more dense inner cloud, flattened in toward the solar plane, extending out a few thousand AU from the sun and which may contain as many as six trillion comets.

In total, there are at least ten trillion and perhaps as many as a hundred trillion comets in a spherical shell surrounding the plane of our "traditional" solar system.

Galactic Years

Although we have become accustomed to viewing our solar system as the sun surrounded by the flat plane of its planets, we can perhaps better see it as a spherical egg, within which the yolk spins, swirling the white substance in two layers, the flat solar plane and the inner shell of comets. The entire egg itself orbits around the center of the Milky Way galaxy, about two-thirds of the way to the visible edge, at a speed of approximately 220 kilometers per second, taking about 225 million years for each orbit, or galactic year. Thus, in galactic years, our solar system is only an adolescent, about 15 years old.

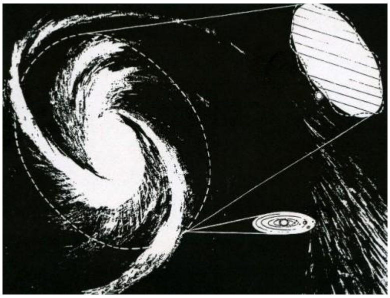

Illustration 2

Within each of these orbital years, the sun slowly moves up and down through the galactic plane like a carousel horse, with each up-and-down cycle taking approximately 62 million years, causing it to move through the galactic plane every 31 million years. (Illustration 2)

Another way of looking at the sun's orbit is to see it as a standing wave similar to that exhibited by the path of an electron around a nucleus, albeit far slower and with less frequency between successive crests.

Earth's Siblings

This then is the immediate world we live within, and, even into the lives of some who read this, this was the only “universe” known, until our powers of observation improved sufficiently to locate other galaxies beyond the Milky Way. But, before moving on to describe our galaxy and the balance of the universe more fully, let us pause for a moment to reflect upon the siblings of Earth and the uniqueness of this small planet we live on.

The first four planets of the solar system, Mercury, Venus, Earth and Mars are spherical rocks, with iron cores. On Mercury and Mars, most atmospheric gas has been evaporated and blown away by the solar wind, and Earth is the only one with an atmosphere that permits the accumulation of liquid water.

The asteroid belt follows Mars, and it may have been prevented from forming into a planet by the gravitational tidal forces of the next planet. Jupiter is the largest planet in the system and is primarily composed of gases, as are the next three planets, Saturn, Uranus, and Neptune.

Mother Earth and Her Dancing Partner

The earth has yet to cool enough to solidify the molten rock that circulates around her inner core of iron. The crust upon which we live floats on this molten mass, and is very thin in comparison to the entire planet, proportionately as thin as the shell of a bird's egg.

The earth's radius is approximately 3,964 miles, or 6,378 kilometers. The solid crust ranges from 25-60 kilometers under the continents and just four to eight kilometers under the oceans. Although we perceive our landscape as greatly varied between tall mountains and oceanic depths, if the earth was reduced to the size of a billiard ball, its surface would appear just as smooth.

The molten core not only acts to provide warmth against the bitter cold of the vacuum, but, the movement of electrons between its various layers also sets up electric currents which swirl outward and manifest themselves in a magnetic field that encloses Earth in its embrace. This magnetic field helps protect us from solar radiation by reflecting and channeling the radiation into the magnetic poles of the planet, which we see as the auroras.

During the period of planetary formation, extending from about four-and-a-half billion years ago to about four billion years ago, all the planets were built up by the impact and adhesion of innumerable objects.

It was during the Late Heavy Bombardment, which lasted 20 million years, that meteorites likely carried in the water, oxygen, carbon dioxide, and organic compounds that allowed Earth to become a greenhouse for life.[67]

During that same period, the earth probably collided with a planetary object the size of Mars, and their combined momentum produced so much heat that it melted whatever crust Earth may have built up, leaving only a molten ocean on its surface. The object itself was destroyed in the collision, and whatever metallic core it originally contained merged with that of the earth's.

The object's outer layers then joined with the earth's crust in being splashed out into space, forming a ring around the earth on a slight tilt from the equatorial plane. With time, the ring coalesced into the moon. Finally, any residual rotational energy the moon possessed was surrendered to the stronger gravitational pull of Earth, locking the moon into a stable orbit in which she always presents the same face to the earth.

Earth is different from the other planets in having an orbiting moon which is far larger in proportion to the size of the earth (1:4) than the moons of any other planet. With its tilted orbit and massive presence, our moon tugs the tides, which tune the oceans to the harmonies of life.

The force of the impact may have dramatically increased the spin of the earth, giving us our brief 24-hour day, rather than the retrograde, slightly less than one-year day of our sister planet Venus. The collision may have also caused the slight tilt in the earth's axis, which provides us with the seasons and, consequently, the nursery within which life could begin.

Today, the earth and the moon embrace each other in a gravitational dance as they waltz together around the sun, first one, then the other closest to the sun. The odds are that, without the moon and the manner in which it formed, life would never have arisen on Earth. Calculating all of our chances, it may be that only

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[67] Johnson, John, Jr., "Meteors may have brought building blocks of life to Earth billions of years ago," *Los Angeles Times*, June 6, 2009.

one such opportunity can arise in an entire galaxy, such as our Milky Way, during its lifetime.

The Milky Way

During the first part of our universe's formation, until about seven or eight billion years ago, the universe may have been composed of innumerable clouds of gas, each surrounding a tiny irregularity in the original expansion.

The movement and gravitational attraction of these clouds of dust and hydrogen and helium gases caused them to regularly collide and merge together and to form ever-larger galaxies of stars. Since then, it is estimated that at least half of the galaxies have merged with other galaxies of a similar size.

It is believed our Milky Way galaxy slowly formed from perhaps a million smaller gas clouds. Each new collision with a gas cloud would set off a burst of star formation resulting in the globular clusters that spherically surround the Milky Way in much the same way that the Öpik-Oort Cloud surrounds the solar system.

These globular clusters are as old as the universe and as young as seven billion years. The gas left over from these cluster formations joined with the Milky Way, enlarging its size and increasing its gravitational attraction for other clouds.

With time, the Milky Way formed its spiral arms, which can be seen as density waves, behind which stars, such as the sun, back up until they are able to pass through the traffic jam, as the stars move more rapidly around their orbits, than the Milky Way revolves around its own center.

The Milky Way contains approximately a hundred billion stars, of which the sun is only a mediocre representative, but, for whom our God of Wisdom may have a particular concern for the gift of its third child and the progeny of her womb.

The life span of the Milky Way itself is limited, as it inexorably attracts and is attracted by other galaxies. In time it will merge with the spiral galaxy known as M31, which we can see as the nebula of the Andromeda constellation and which is the only galaxy which appears to be approaching us. However, since M31 is still two million light years away, we have little to worry about at the moment.

Although the stars within merging galaxies are sufficiently spread out so that they do not actually collide when two galaxies meet, the clouds of dust and gas within the galaxies and its surrounding "dark matter" do come together. The resulting shock waves and gravitational chaos set off a spectacular display of brilliant blue-white stars.

It seems to be the fate of all spiral galaxies ultimately to collide with others in the formation of giant elliptical galaxies. Perhaps, just as the rarity of circumstances limits the number of life-sustaining water planets, with large moons, orbiting in just the right place around warm yellow singular stars without a binary twin, even this chance of life may only occur in virginal spiral galaxies.[68]

The Balance

If we imagine the sun to be the size of a shirt button, we would not find the next star, or button, until we traveled 90 miles down the shirt front. However, if we imagine the entire Milky Way as a shirt button, the next one down, the M31 galaxy, would be located only five inches down the shirt.

Then, since both the Milky Way and M31 are part of the same "Local Group" of galaxies, the same analogy of using a button for the Local Group would place the next button, the "Sculptor Group," 24 inches down the shirt front. Thereafter, we could find hundreds of similar buttons concentrated in the space of a basketball about 10 feet away, and the next cluster of buttons would be about 65 feet away.

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[68] The concept that the earth is a living being was proposed by James Lovelock in *The Ages of Gaia: A Biography of Our Living Earth,* (W. W. Norton and Company, Inc., 1988). If this is true, then Mother Earth herself is a favored daughter of a living universe.

Using the same scale of distance, our entire universe, including the most distant clusters of galaxies, could be hung out to dry within a spherical clothesline with a one-kilometer diameter. Relatively, we can see that galaxies are much closer together than are the stars to each other within the galaxies.

Life in the Future

The conditions that allow life to exist on Earth are fragile and subject to a wide variety of catastrophes which occur in a chaotic and unpredictable manner. Someday, the pleasant conditions we enjoy will end and human life will no longer be tenable on Earth. That day may be tomorrow, or it may be five billion years from now, but the only thing for certain is that the end will come. What is uncertain are the manner and the means; however, there are a number of alternative scenarios.

It will be billions of years before the death of our sun or the universe, but for Earth and for those of us who inhabit its surface, an earlier end is virtually certain. Of all the physical threats to the existence of human life on Earth, the greatest danger is that of a collision with a comet or asteroid, given the fact that Earth moves about its orbit at a speed of 67,000 miles per hour and collides with a killer rock about 10 km across about once every hundred million years.

Since the deepest spot in the oceans is only about 11 km deep, with the average about 3.7 km, it really doesn't matter where the comet or asteroid strikes, it's going to destroy most life on Earth.[69]

On a smaller scale, an object bigger than one km in diameter strikes Earth about 60 times every 10 million years, or about once

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[69] The background for this section was primarily drawn from Gribbin, John and Mary Gribbin, *Fire On Earth: How Asteroid and Comet Collisions Have Shaped Human History—And What Dangers Lie Ahead,* (St. Martin's Griffin, 1996); Barnes-Svarney, Patricia, *Asteroid: Earth Destroyer or New Frontier?,* (Plenum Press, 1996); and Zebrowski, Ernest, Jr., *Perils Of A Restless Planet: Scientific Perspectives On Natural Disasters,* (Cambridge University Press, 1997).

every couple of thousand years. Such a collision results in a crater about 13 km in diameter and releases an explosive force of about 20,000 megatons of TNT.

During the formation of the solar system about 3.8 to four billion years ago, Earth and the other planets were impacted by numerous comets and asteroids in what is called the Late Heavy Bombardment.

Subsequent impacts have remained relatively constant since about 3.5 billion years ago, primarily resulting from the sun's 62-million-year cycle of bobbing up and down in its path around the Milky Way galaxy. (*See above* Illustration 2) As a result, the solar system passes through the galactic plane every 31 million years, which disrupts comets from the Öpik-Oort Cloud causing a swarm of comets to move through the inner solar system.

The earth and the rest of the solar system are just above the plane, and consequently have experienced increased comet activity during the last one to five million years.

The crossing of the galactic plane 65 million years ago may have caused a large asteroid or comet to strike the Yucatan Peninsula in Mexico near where the village of Puerto Chicxulub (Mayan: tail of the devil) is now located. The impact dug out a crater 180 km in diameter and caused the extinction of the dinosaurs.

During the crossing about 35 million years ago, the earth was struck by a comet or asteroid that created a crater 85 km across—which we now see as Chesapeake Bay.

Even if a comet does not strike the earth, it can still threaten our lives, particularly if it crosses Earth's orbit. As it sweeps through the inner solar system, a comet slowly disintegrates leaving behind an ever-expanding tube of dust and debris through which the earth must pass each year as it orbits the sun.

The most spectacular examples are the Taurid meteor showers resulting from the breakup of Encke's Comet, originally a giant about 100 km across that split up tens of thousands of years ago. The earth spends almost half of the year flying through its debris, entering in

April and emerging in late June during the Beta Taurids. The earth then reenters on the other side of the sun in October, resulting in the Alpha Taurids between November 3 and 15, before coming out in December.

Encke's Comet also accounts for seven of the 80 known "Apollo" asteroids (those that cross Earth's orbit). The largest is Hephaistos, which is about 10 km in diameter.

One likely result of the breakup of Encke's Comet is known as the Tunguska event. It occurred on June 30, 1908 during the Beta Taurids at a location north of Lake Baikal in Russia. An asteroid or a meteor entered over western China, moving from southeast to northwest, and exploded 15,000 feet above the ground. The blast wave devastated approximately 2,000 square km of forest with a force equivalent to 20 to 100 megatons of TNT.

In comparison, the Hiroshima atomic bomb possessed a force of only 100,000 kilotons of TNT, while the largest nuclear warhead ever tested reached 57 megatons and the largest operational warheads only possess a destructive force of 25 megatons. A one-kilometer asteroid explodes with the energy of about a million megatons of TNT, and a fireball with the energy equivalent of the Hiroshima bomb is produced high in the atmosphere about once a year by minor cosmic impacts.

The Perseids meteor shower arrives on or around August 11-12th each year as a result of Comet Swift-Tuttle, a 10-kilometer giant, whose orbit continues to intersect that of Earth's. It was first recorded in 68 B.C.E., later reported in Chinese journals dated in 1737, and subsequently found to have a period of 130 years. It last appeared on September 26, 1992, when its predicted date of arrival was off by 17 days.

New calculations predict the next appearance of Swift-Tuttle on August 14, 2126, when it is expected to miss Earth by 24 million kilometers; however since it is locked in a gravitational embrace with Jupiter, with 11 orbits of Jupiter for each orbit of the comet, it will closely approach Earth for at least the next 10,000 years, and the exact dates of its arrivals cannot be known.

Swift-Tuttle poses one of the greatest dangers known to Earth and will continue to be a threat for a very long time in the future.

We are presently aware of approximately 300 objects greater than 1,000 meters in diameter known to have orbits that intersect Earth's, and we find about 30 new objects each year; however, it is estimated that we are only aware of about eight percent of those which threaten Earth.

Following are the most significant recorded sightings and events that have endangered our present generation:

On February 12, 1947, forty years after the Tunguska event and about 5,000 km east, or about 375 km from Vladivostok, Russia, a meteorite with a mass estimated at 100 tons disintegrated in the air with an explosive power equal to several megatons of TNT. It rained down debris causing 120 craters.

In April 1972, a fireball was observed traveling south to north over the Rocky Mountains in the western United States. It rained down a glowing trail of tiny meteors as it skimmed through the earth's atmosphere about 55 km above Montana before heading back out into space above Canada. Its size was as much as 1,000 tons, far larger than the comet or asteroid which caused the Tunguska event.

On April 15, 1978, a United States military satellite recorded a meteor with a five-kiloton yield bursting into a fireball in the daytime over Indonesia. For one second the fireball would have been as bright as the sun to someone looking up from below.

On the night of April 9, 1984, the pilot of a Japanese cargo plane traveling 644 kilometers east of Tokyo, Japan, observed the explosion resulting from the splashdown of an asteroid in the nearby ocean. The resulting giant mushroom cloud rose from about 4,000 to 18,000 meters in two minutes.

On March 23, 1989, an asteroid with a diameter of 200-500 meters came within 691,870 km of Earth's orbit. Had the earth arrived in its orbit only six hours earlier, the asteroid would have struck Earth with an explosive force equivalent to more than a million tons of TNT. It would have created a crater about seven kilometers in diameter and ejected enough debris into the atmosphere to cause a global disaster.

On February 1, 1994, a meteor entering the earth's atmosphere was recorded by six United States spy satellites. Traveling on a northwest to southeast path, it entered the atmosphere far north of New Guinea. Crossing the equator, it exploded 20 km above the sea northwest of Fiji. The meteor was moving at about 20 kilometers per second, or 72,000 km per hour, had a mass of more than a thousand tons, and exploded with a force of about 100 kilotons of TNT.

On March 15, 1994, a 10-meter asteroid passed by at less than half the distance between the earth and the moon. The asteroid was first observed just the day before as it narrowly missed the earth. One such close encounter has been observed each year during the last decade; however it is estimated that unnoticed near misses (or hits) probably occur about once or twice a week.

In May of 1996, a 1,000-meter asteroid was discovered only four days before it crossed Earth's orbit, missing by only four hours.

On January 7, 2001, a massive, 500-meters-wide asteroid passed within 600,000 kilometers of Earth. Had it struck Earth, nothing within 150 kilometers of the impact would have survived.

On June 17, 2002, researchers discovered that an asteroid 150-300 meters in diameter moving at approximately 23,000 miles per hour had just passed within 75,000 miles of Earth three days before. Reporting scientists stated that asteroids of about 100 meters in diameter pass within 250,000 miles of Earth about 50 times a year.

Declassified United States military data indicate that satellites detected 136 atmospheric explosions with yields of one kiloton or more between 1975 and 1992. Since these events occur in the infrared spectrum, they are not usually visible from the earth's surface and, since the satellites are programmed to watch for unnatural events such as nuclear detonations, it is likely that there may have been at least 10 times more events than were reported.

In 1998, astronomers announced that a mile-wide asteroid known as 1997 XF11 may be on a near-miss or collision with Earth on October 26, 2028. Although they calculate that it should miss Earth by 30,000 miles, the estimate has a margin of error of 180,000 miles!

If 1997 XF11 were to collide with Earth at its speed of more than 17,000 miles per hour, it would explode with an energy of approximately two million Hiroshima-sized atomic bombs. On land, it would leave a crater 20 miles across and its dust cloud would darken the sun for weeks, if not months.

Even without striking the earth, passing comets create a “zodiacal” dust cloud which covers most of the inner solar system. As the earth moves in its orbit, it sweeps up several thousand tons of dust every day, most of which is too fine to burn as meteorites and which slowly rains to the surface.

Depending on its concentration, which varies, the zodiacal dust may contribute to a major cooling of the earth about once every hundred thousand years resulting in periodic ice ages separated by warmer periods lasting about 15,000 years. Since it has been about 10,000 years since the last ice age ended, another ice age is probably waiting down the road, just around the corner.

Earth's Fiery End

Over the eons, the sun will continue to become warmer and, in about another billion years or so, the earth's oceans will boil away and she will no longer be able to sustain life. About 7.59 billion years from now, the sun will finally exhaust its store of hydrogen, first in its core and then in the outer layers, and it will balloon out into a giant red star, 256 times larger than it is now and 2,730 times as bright.

The earth will skim along the flame tops and will slowly surrender to the gravitational tug of the sun, until the day she spirals down and rejoins the mass from which she was born.

Together, they will ultimately become a tiny dwarf star and will slowly fade away.[70]

[70] Overbye, Dennis, "Kissing the Earth Goodbye in About 7.59 Billion Years," *Los Angeles Times*, March 11, 2008.

ANCIENT GEOMETRY

Although the Greeks provided the word *geometry* (to measure the earth) and raised its study to become a virtual religion, they themselves recognized that their original knowledge came from the Egyptians.

It is not known to what extent the Egyptians themselves inherited their science from more ancient civilizations, but they demonstrated their knowledge of advanced geometric principles in their megalithic building projects, most accurately in the construction of three pyramids traditionally associated with the pharaohs of the Fourth Dynasty (2575-2467 B.C.E.), Khufu, his son Khafre, and grandson Menkure.

This traditional dating is now being questioned by persuasive evidence that the foundations of these three pyramids, associated temples and the Sphinx may have been laid out and constructed as early as the Eleventh Millennium B.C.E., and the pyramids and megalithic temples were only later completed and restored by the Fourth Dynasty almost nine thousand years later.

No matter how the Ice Age ended, the melting of its massive glaciers caused the raising of sea levels worldwide and released gigantic amounts of moisture into the atmosphere, which fell as heavy rains.

During this recovery period, Egypt was blessed with an abundance of rainfall and a moderate climate. The Sahara was dotted with lakes and blossomed with vegetation, and the area around the Nile River may have been one of the most pleasant places on Earth to live.

A three-thousand-year golden age of agriculture began in Egypt around 13,000 B.C.E. with the use of sickles to harvest grains and grinding stones to process flour.

The archeological record shows a decline in farming after 10,500 B.C.E. with a return to fishing, and the geological record provides evidence of great flooding at about the same time.

A dry spell then lasted for thousands of years until about 7000 B.C.E. when increased rains introduced the "Neolithic Subpluvial" epoch which lasted for about 4,000 years, during which the weather was again quite pleasant.

By 3000 B.C.E., the weather patterns changed to the hot and dry climate that continues to exist in Egypt.[71]

From erosion patterns caused by running water on the flanks of the Sphinx and the walls of the Valley Temple (traditionally associated with the second, or Khafre Pyramid), geologists have determined that these structures were carved and constructed as early as 10,500 B.C.E., and no later than 5000-7000 B.C.E.[72]

The stones used in the construction of the Valley Temple, some weighing more than 200 tons, were carved from the bedrock around the Sphinx, and the first 30 feet of Khafre's Pyramid were also built of megalithic stones.

Both the Khafre and Khufu pyramids may have been earlier laid out and constructed as flat-topped elevated platforms with slanted interior passageways and shafts aligned for the observation of various stars. In the same way that precession causes the shifting of the constellation background at the spring equinox, the same

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[71] Graham Hancock, op. cit., who relied on Hoffman, Michael, *Egypt Before the Pharaohs,* (Michael O'Mara Books, 1991); and Wendorf, Fred and Romuald Schild, *Prehistory of the Nile Valley,* (Academic Press, 1976).

[72] West, John Anthony, *Serpent in the Sky,* (Harper & Row, 1979) establishes the earliest dating. The later date is attributed to Robert Schock, a professor of geology at Boston University.

phenomenon provides an up-and-down motion of all visible stars over the same 26,000 year cycle. (*See above* Illustration 1)

In 10,450 B.C.E., the constellation of Orion would appear above the southern horizon at its lowest point in the cycle. At the same time, the arrangement of the three belt stars in relationship to the Milky Way were exactly duplicated on the ground by the placement of the three pyramids in relationship to the Nile River.[73]

Today, Orion rises almost due east and is close to attaining its highest point in the sky above the southern horizon.

When the Great Pyramid was completed by Khufu, it included several diagonal shafts that originated in the King's and Queen's Chambers. The southern shaft (4.8 x 8.4 inches) from the King's Chamber is sighted on where the belt of Orion would have been between 2600-2400 B.C.E. The southern shaft (8 x 9 inches) from the Queen's Chamber was aimed at the meridian transit of Sirius around 2400 B.C.E.

From the orientation of these magnificent structures, the ancients were able to preserve a record in stone establishing when the constructions were built. By the architecture they used, they were able to demonstrate the sophistication of their knowledge, their understanding of the world they lived upon, and its geometry.

A measure of Egyptian science was taken when the country was visited by the Greek historian, Herodotus, who recorded his observations in *A History* in about 440 B.C.E. Through these friendly visits, the Greeks acquired the practical knowledge of the Egyptians, based on thousands of years of observation and experience, reduced these secrets to pen and paper illustrations, and used their alphabetical written language to more accurately describe their methods.

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[73] Hancock, Graham, op. cit.; Bauval, Robert and Adrian Gilbert, *The Orion Mystery,* (Heinemann; Crown; Doubleday, 1994); and Bauval, Robert and Graham Hancock, *The Message of the Sphinx,* (Crown, 1996).

The Right-Angle Theorem

It appears that Mother Nature provided the impetus for the Egyptians to put their science to practical use. Each year the Nile would overflow its banks, depositing a thick layer of rich silt, and would wash away many property markers. To determine land ownership and to facilitate the collection of taxes, the priests had to annually oversee the surveying of vast fields in the Nile Valley.

Egyptian surveyors probably used a tool known as the "twelve-knot rope," which may have been used in other ancient locations as well. A long rope was divided into 12 equal lengths by knots with the ends tied together, and was then stretched in a triangle around three posts, so that one side equaled three lengths, one four lengths, and the other five. The 90º right angle produced by the rope could have been used to lay out vast plots of land, requiring accurate corners and very long straight lines. The surveyors came to be called "rope stretchers," from the teams of slaves used to carry and position the long ropes and large stakes. (Illustration 3)

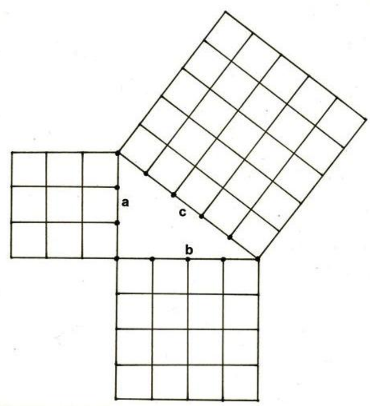

Illustration 3

At some point, it was learned that the square on the hypotenuse (side opposite the right angle) of the triangle always equaled the sum of the squares on the other two sides or legs. Thus, 3x3=9, 4x4=16, 9+16=25 and 5x5=25. Algebraically, the theorem or equation is stated as: $a^2 + b^2 = c^2$.

Among the Classical Greeks who studied the ancient knowledge was Pythagoras of Samos (ca. 569 - ca. 475 B.C.E.), who lived for a number of years in Egypt. He provided a proof for the right-angle theorem and established a society for its study. Thus, this method of calculating right angle proportions became known as the Pythagorean Theorem, although it was already ancient when Pythagoras learned it.

The proportions 3:4:5 were used to construct the Khafre Pyramid, which may have been the first constructed on the Giza plateau. It is set on the highest point, and the first 30 feet were built with megalithic stones, indicating that it may have been originally used as a flat-topped geodetic observatory before being later completed as a pyramid.

Each side of the base of Khafre's Pyramid (AC) is equal to 246 cubits, its perimeter measures 984 cubits, its height (DE) equals 164 cubits, and its apothem, which connects the center of each side to the top (BD), can be measured by 205 cubits. (Illustration 4)

Each of these measurements can be divided by 41, resulting in proportions of 24 for the perimeter, three for half of a side (AB or BE), four for the height (DE), and five for the apothem (BD).

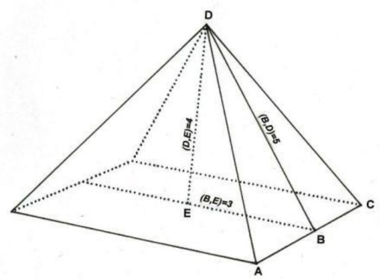

Illustration 4

The cubit used in the construction of Khafre's Pyramid may have been approximately equal to 7/8ths of a modern meter.[74] It is equally probable that other lengths of measurement were used, such as the royal cubit of 525 millimeters; however, in every case, the proportions of the internal right-angle triangle formed by half of the base, height, and apothem are 3:4:5.

If we stand at the center of one side of the pyramid and look up at the top along the apothem (BD), we can use the visible outside measurements to determine the invisible internal height (DE). Referring again to Figure 4, we can subtract nine (the square of the half-base (BE)–three) from 25 (the square of the apothem–five), to arrive at 16 as the square on the height.

Then we can determine the square root (√) of 16 to be four which gives us the height of the pyramid.

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[74] Tompkins, Peter, *Secrets of the Great Pyramid,* (Harper & Row, 1971).

Thus, as long as we know any two of the sides of a right angle triangle, we can calculate the length of the other side by use of this theorem.

The proportion was also built into the "King's Chamber" of the Khufu, or Great Pyramid. The floor measures 10 (AD) by 20 (AB) cubits and the height of the ceiling measures 11.18 cubits (CD). First, we must divide each of these by five to reduce the proportions, finding them to be 2:4:√5(2.236). (Illustration 5)

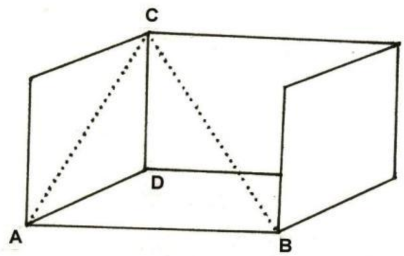

Illustration 5

If we use the right-angle theorem, we can deduce that the diagonal on the side wall (AC) is equal to three (since 2x2=4 plus √5x√5=5 for a total of nine, whose square root is three). Next, we can deduce the long diagonal from one corner of the ceiling to the opposing diagonal corner on the floor (BC) as equal to five (since 3x3=9 plus 4x4=16 for a total of 25, whose square root is five).

Thus, the internal right-angle triangle consists of the length of one side of the floor (AB=four), the diagonal on the side wall (AC=three), and the long diagonal from the ceiling to the opposite corner on the floor (BC=five).

The 3:4:5 right-angle triangle became known as "the supreme principle of the production of the world" according to the Jewish writer Philo (20 B.C.E. - 50 C.E.), and the total of its squares, 9, 16, and 25, or 50 became a sacred number represented by the Hebrew letter N.

One of the Dead Sea Scrolls, the *Manual of Discipline* (or *Community Rule*) may be making such a reference when the writer spoke of the "holy of holies and the letter N" meaning, "the supreme sacredness of the number 50."

Pieces of Pi

The Egyptians also made use of another basic geometric formula in calculating the length of a circle constructed from a given radius. It is not difficult to imagine the Egyptian priests placing a stake in the sand and using different lengths of rope to trace out large circles.

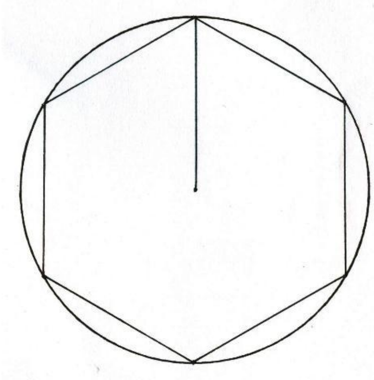

Illustration 6

When they laid the rope into the circular groove, they found that three lengths of the radius were almost long enough to measure a half circle, but it was always a little bit short. The shortage can be illustrated by constructing a hexagon with sides equal to the radius within the circle it produces. (Illustration 6)

The measure of the outside curved line traveled by the tip of the radius and the space it contains results in the essential mathematical proportion known as *Pi.* The value of *Pi* has been calculated by modern computers to trillions of decimal places, but the first ten places are usually sufficient for most calculations, 3.14159 26535.[75]

In 1858, one of the most ancient mathematical documents was discovered wrapped in a mummy by the Scottish Egyptologist Alexander Henry Rhind (1833-1864). Known as the Rhind Papyrus (or the Ahmes Papyrus after its scribe, the priest Ahmes) and copied around 1650 B.C.E. from an earlier document, the papyrus contains 84 problems and their solutions.

Problem 50 states that a circle has the same area as a square whose side is 8/9 the diameter of the circle. Algebraically, and with the diameter designated as d, the problem can be restated as *Pi*(d/2)2 = [(8/9)d]2. After cancelling d^2 from both sides of the equation, the

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[75] Beckman, Petr, *A History of π (Pi),* (St. Martin's Press, 1971).

result is *Pi*/4=64/81, or *Pi*=256/81, for a decimal value of 3.16049, which is slightly too large.

Measurements of the Khufu Pyramid indicate that the knowledge of geometry in more ancient times may have been much more accurate than that later recorded by Ahmes.

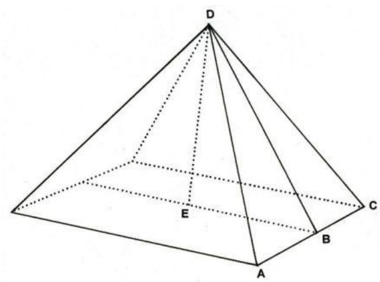

Illustration 7

The Great Pyramid appears to have been constructed according to a royal cubit equal to approximately 0.524148 meters. Irrespective of the measuring standard and the fact that the top of the pyramid is missing, it is generally conceded that the original height (Illustration 7 DE) was probably intended to be equal to 280 cubits, that each side of the base (AC) was measured by 440 cubits, and the perimeter by 2x880=1,760.

Irrespective of the measure, the ratio of the perimeter is always approximately equal to the height multiplied by *Pi* times two, an unlikely accident. Thus, using the modern value of *Pi*, (3.14159 26535) and a height of 280, one half of the perimeter is equal to 879.645942980, slightly less than 880.[76]

Most likely, the ancients used a value for *Pi* based on the continuing fraction 22/7, which results in 3.142857 142857. . . . When this value is substituted and multiplied times the height (280), the result is exactly 880. Moreover, when the height (280) and half perimeter (440) are each divided by 40, the results are seven and 22, the very numbers of the magic fraction.

Using these numbers we can construct a drawing of the square base and a circle of the same length, and a radius or height, all constructed with the same units of measure. (Illustration 8)

[76] Tompkins, Peter, op. cit.

The proportion produced by 22/7 must have appeared magical, as it almost perfectly measured both the square and the circle. Indeed, if 0.142857 is multiplied times seven, the result is 0.999999, or essentially one. Thus, in a further refinement, the radius of seven can be seen as an approximation of one composed of seven pieces of 0.142857 and that the circumference, 2*Pi*, is accordingly composed of exactly 44 pieces.

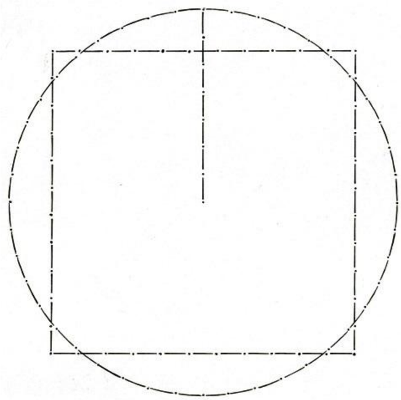

Illustration 8

Or, we can imagine that the height (7x7) can be equal to 49 of these pieces of *Pi*, and the circumference is equal to 308 pieces of *Pi* (7x22x2). Moreover, when it comes to accurately knotting a long rope into equal lengths of cubits, each divided into seven parts, the height can be measured by1,960 pieces, each side by 3,080 pieces, and the circumference by 12,320 pieces.

In the Third Century B.C.E., a Classical Greek scholar, Archimedes of Syracuse (ca. 287-212 B.C.E., used rudimentary algebra to construct an imaginary polygon of 96 sides inside and a slightly larger one outside a circle to determine that the value of *Pi* stood between the product of 3 10/71 and 3 1/7 (which results in 22/7).

The accuracy of this approximation can be gauged if we use the most modern measurements of the Great Pyramid base in inches, for a total perimeter of 36,277, and divide by 2*Pi* to calculate the height in inches. The result with modern *Pi* is 5773.760079870 inches, and with ancient *Pi*, it is 5771.437079545. Thus, at a height of 160 yards, or longer than 1 1/2American football fields, the error is only 2.323000325 inches, reflecting the 0.012644890 difference in the two derivations of *Pi*.

Archimedes established the area of a circle by proving that the area of a right triangle having a side equal to the radius of a circle (Illustration 9 AB) and the other equal to its circumference (BD) would have the same area.

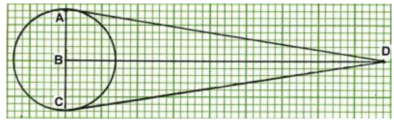

Illustration 9

If we use the modern formula which provides that the area of a circle equals *Pi* times the radius (r) squared (A=*Pi*r^2), and use a radius of seven, we can first determine the circumference of the circle to be 43.982297149 (*2Pi*r) and its area to be 153.93804021 (*Pi*x49). Then, if we double the long isosceles triangle along the "circumference" line and use the formula (A=1/2bxh), which says that the area of a triangle is equal to one half the base (7) times the height (43.982297149), we can easily calculate an area for the double triangle of 307.876080043. Dividing that number by two produces 153.93804021 for the area of the original triangle, which is exactly the same as the area of the circle.

Archimedes also theorized that the area of a circle is to a square on its diameter as 11 is to 14. If we again use a radius of seven and again find the area of the circle to be 153.938040021, we can divide by the proportion 11 to give us 13.994367274. (Illustration 10)

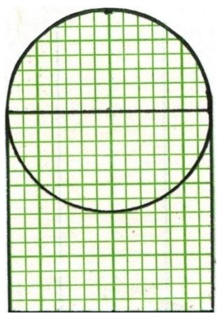

Illustration 10

To compare the two, we can square the circle's diameter of 14 to produce 196 which, divided by the proportion 14, again gives us 14, which is close to 13.994367274. However, if we substitute ancient *Pi* at 3.142857, we find the circle's area to be 153.9999999, which divided by the proportion 11 gives us exactly 14.

If we divide the original proportions, 14 by 11, the answer is 1.27272727, another magical number we will next encounter as the approximate square root of the Golden Proportion.

The Golden Proportions of Phi

It appears the ancients also used another geometric marvel called the Golden Proportion, or Ratio, by the Classical Greeks. It is usually defined as that point where any line or measure can be divided into two parts in which the smaller is proportional to the larger in the same manner that the larger is to the total. The Golden Proportion, also known as *Phi*, is 1.61803389.

To demonstrate how the Golden Proportion is derived, one needs to draw a line (Illustration 11 AC) divided in half (B), and construct a right angle with the side line (CD) equal to half the base line length (AB).

If the two lengths are connected by a hypotenuse (AD) and the length of the side line is subtracted from the hypotenuse, the remainder (AE) is equal to the Golden Proportion of the base line (AP).

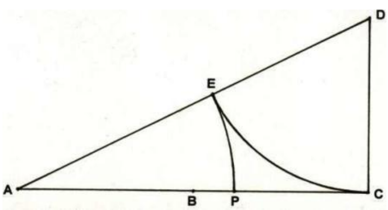

Illustration 11

The Golden Proportion is also calculated as one plus the square root of five divided by two, $(1+\sqrt{5})/2=1.61803389$. To demonstrate how this formula is derived, we can again rely upon Illustration 11 using a base length of two (2x2=4) and a side of one (1x1=1). We can use the right-angle theorem (4+1=5) to determine the hypotenuse must be equal to the $\sqrt{5}$ (2.236067977).

Using the Golden Proportion formula, we add one to 2.236067977 ($\sqrt{5}$) and divide 3.236067977 by two, to arrive at the Golden Proportion, 1.61803389.

If we substitute a length of one and a height of 0.5, the hypotenuse must equal the $\sqrt{1.25}$ (since 1x1=1 plus 0.5 x 0.5=0.25 equals 1.25), or 1.118033989. Then, when 0.5 is subtracted from 1.118033989, the result is 0.61803389, the Golden Proportion of one, which is known as the Golden Mean.

Just as the ancients relied on the magic fraction 22/7 for a working value of *Pi*, it also appears that they may have known that the related fraction 196/121 produces a near value of 1.619834711 for the Golden Proportion.

They also knew that the square root of the Golden Proportion could be determined by four divided by 3.1428574 (or 14/11) which equals 1.272727. Thus, the ancient value for the square root of the Golden Proportion is only slightly lower than the modern value of 1.273239.

Using 1.272727 as the square root of the Golden Proportion, the ratio between the height of the Great Pyramid (280 cubits) and its half base (220) is exactly equal to the square root of *Phi*, (220 x 1.272727 = 280).

If we again use the right-angle theorem, we can first calculate an apothem equal to 356.089 in order to discover that each face (Illustration 12 ABCD) has almost exactly the same area [1/2base (220) times the apothem (356.089)], 78,339.58, as a square on the height (DEFG) [2802=78,400].

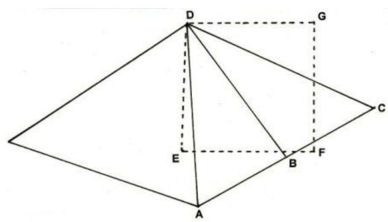

Illustration 12

This ancient proportion can also provide a correct solution of the secret formula defining the Round Table of the Grail, which was probably based upon ancient Hebrew and Egyptian documents recovered in Jerusalem by the Knights Templar during the Crusades and which formed a part of their esoteric knowledge.[77]

This formula [*Phi*^{2}(12/10)=*Pi*] attempts to reconcile the areas of a circle, square, and rectangle, each having a perimeter of eight. This results in the radius of a circle, with a circumference of eight, being

[77] The formula for the Round Table of the Grail, and the drawing on which Illustration 13 was based, is set forth in Appendix I of *Bloodline of the Holy Grail* by Laurence Gardner, (Element Books, Ltd., 1996). The formula was also found by Schwaller de Lubicz in the tomb of Rameses IX, except that the fraction 6/5 is relied on rather than 12/10 for producing the decimal number 1.2.

approximately equal to the square root of the Golden Proportion in the same manner that 4/*Pi*=√*Phi*.

If we insert modern values into the formula, we find that *Phi*² (2.618033989) times 12/10 (1.2) equals 3.141640786, which accurately produces the first three places of *Pi*. Then, using a value of two for each side of the square (Illustration 13 ACDE) and a perimeter of eight, we can find that half of one side (AB=1) times the square root of the Golden Proportion equals the radius r), or 1.273239, which times *Pi* equals 3.999998289, or approximately one half the square's perimeter. Thus the formula does provide an approximate basis for comparing the circle, rectangle and square, all having a perimeter of eight.

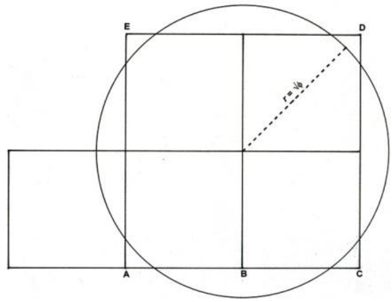

Illustration 13

For a better solution of the mystery, we must first substitute the ancient fractional value of 1.619834 for the Golden Proportion, and use its square root, 1.272727, for the radius, then multiply by ancient *Pi* (3.1428574), to get exactly four for half the perimeter of the circle.

Next, we substitute a perimeter of 44 (ACDE) and 11 for each side of the square, finding one half of a side (AB) to be 5.5, which, when multiplied by 1.272727, results in a radius r) of exactly seven. Then, when seven is multiplied by ancient *Pi* (3.1428574), the result is 22 for one half of the circle and exactly 44 for the perimeter of all three shapes for King Arthur's table.

However, if we multiply the ancient value of the Golden Proportion squared (*Phi*²) times 1.2, the result is 3.148634625, which is slightly less accurate than both the modern and the ancient value of 3.142857 for *Pi*, but still better than Ahmes'.

The reason is that four divided by *Pi*, or 14/11, provides only a close approximation of the square root of the Golden Proportion, as is the fraction 196/121 only an approximation of the Golden

Proportion. Although the difference is only 0.000512 in decimal calculations, the ancient value for the Golden Proportion cannot compare with the perfect value of *Phi* derived from the √5, as seen above.

The modern value for the Golden Proportion, 1.61803389, when squared, results in the identical decimal proportion, or 2.61803389. All of this only begins to define the essence of its value as a golden internal ratio of all lengths of measurement, however numbered, rationally or irrationally, or exhibited in an eye-pleasing manner, such as the radiating seeds of a sunflower or the spiral of our Milky Way galaxy.

Parabolic Curves

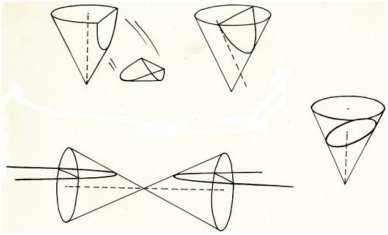

Illustration 14

The primary advancement by the Greeks over the ancient geometry they inherited from the Egyptians was in achieving a partial understanding of parabolic and elliptical curves, which are forms of conic sections. They were interested in these peculiar curves produced when cutting across cones (such as those we use to hold ice cream) of different lengths and circles. These curves came to be known as *parabolas* from the Greek word for comparison.

Conic sections can be observed whenever a circular cone is sliced by a plane parallel to an element of the cone, such as its center line or side. But principally, the Greeks were concerned with the parabola (Illustration 14 top) and the ellipse (Illustration 14 right), which is the path taken by planets around the sun. The hyperbola (Illustration 14 bottom) is produced by slicing two nose-to-nose cones.

Knowledge of parabolic curves resulted in formulas to not only to calculate the volume of conical wine jars in use at that time, but later to determine the best shapes for the hulls of ships, the wings of airplanes, automobile headlights, and satellite receivers.

The parabolic curve also traces the path of a stone tossed into the air in relation to the spinning surface of the earth, the trajectory of an artillery shell, or the path of an intercontinental ballistic missile.

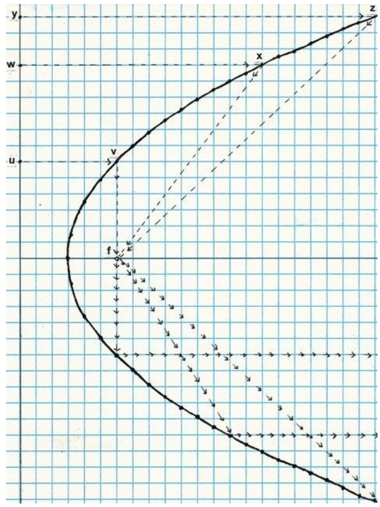

Illustration 15

We can map a simple parabola as a plane curve (v,x,z) generated by a point moving so that its distance from a fixed point, or focus, (f) on a line is equal to its right angle distance from a perpendicular line (u,w,y). (Illustration 15)

Thus a light bulb placed at the focus (Latin: *hearth*) will result in its rays of light being reflected out in parallel lines into infinity, of in the reflection of incoming electromagnetic waves back to the focus.

Once Archimedes divided a circle into 96 pieces to find its approximate value, he turned to the more difficult problem of measuring parabolic curves. He constructed a curve and began to divide its interior by triangles in proportionally reducing its area in a geometric progression.

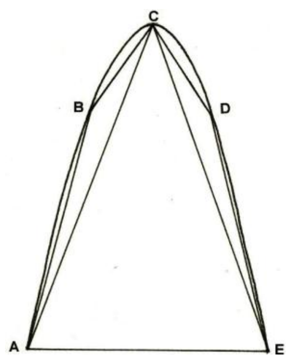

Illustration 16

Assigning one as the area of the Illustration 16 ACE triangle, he found that the fraction 4/3 (1.33333333) defined the practical limits of progression (and the approximate ratio) as the narrowing triangles approached the infinite, a conceptual tool he was missing.

Archimedes may have experimentally engineered his calculations in constructing parabolic mirrors to reflect the sun's rays in an unsuccessful attempt to blind the invading Romans or to burn their ships.

Although he made good use of elementary algebra and guessed correctly that the ellipse was defined by its major and minor axes, Archimedes failed to determine the area under the hyperbolic curve. In addition to the concept of infinity, he also lacked the decimal notation system and the calculus required to provide a rigorous mathematical proof, for which civilization had to wait for almost 2,000 years. Nor did he apparently notice that the fraction 4/3, which he used to measure the interior of the parabolic curve, could also have provided a solution to the volume of a sphere ($V=4/3 Pi r^3$).

Euclidean Geometry

Following the founding of Alexandria by Alexander the Great in 331 B.C.E. and the fragmentation of his empire upon his early death, one of his Greek generals, Ptolemy I Soter, took control of Egypt. With the conquests of Alexander, the age of the Greeks passed from the Classical to the Hellenistic, and its center moved to Alexandria.

Ptolemy's son, Ptolemy II Philadelphus established the Museum and Library of Alexandria and began collecting originals of most of the known books in the world, ultimately totaling more than 700,000 scrolls.

Archimedes' books were surely found on the library shelves, along with other classics, such as the writings of Zeno of Elea (ca. 490-430 B.C.E.), who proposed the problem known as Zeno's paradox. That is, if a runner moves from the start to the finish line in decreasing half-steps (1/2+1/4+1/8+1/16+1/32+1/64 . . .), he will never finish the race, for there will always be another length left to be divided in half, however small and practically invisible.

While the Greeks recognized that certain geometric progressions approached finite limits, such as 22/7 and 4/3, they could not conceive of an infinity, which can only be imagined and could not be proved, therefore, by the mysteries of geometry they inherited from the Egyptians and the ancients.

Among the Hellenistic scholars attracted to Alexandria were Erastosthenes (276-194 B.C.E.), Ptolemy's librarian, who calculated the radius and circumference of the earth to within 5 percent of their true values (thanks mainly to mutually canceling errors), and Euclid of Alexander (ca. 325 - ca. 265 B.C.E.), who compiled all proven geometric theorems into a 13-volume work known as the Elements.

The methods Euclid developed and his articulation of axioms remain a foundation for the study of geometry. Its rigid limitations and consequential utility have been largely replaced, however, by non-Euclidean geometry in the calculation of the modern laws of physics and cosmology, such as those relied upon and articulated by Einstein.

Before Julius Caesar's Roman soldiers murdered Archimedes in Syracuse as he sketched geometric diagrams in the sand, before they accidentally burned the Alexandria library, before the library was again sacked by an orthodox Christian mob and later by Islamic warriors, before the very foundations of the library sank under the harbor waters during an earthquake, and before the Dark Ages descended, great was the ancient knowledge then extant. So much was to be shamelessly destroyed and needlessly forgotten.

Emerging From the Dark Ages

It would not be until the Seventeenth Century that Galileo's telescope would allow everyone with a lens to see clearly for themselves that the earth was round and that it moves around the sun. To reconcile the new evidence, Western scholars resurrected the ancient tools of geometry and mathematics to describe the telescope's revelations, and fueled the race for knowledge that continues to cycle the course at increasingly dizzy speeds.

Among the early contributors to the new sciences was René Descartes (1596-1650), a French intellectual, who is generally credited with the development of analytical geometry. That is, he combined the languages of algebra and Euclid's geometry into a powerful tool to calculate and plot the celestial objects which were first being seen through telescopes to move through space.

Descartes was a soldier who dreamed that God had entrusted him with the key to unlocking the secrets of the universe. He became a philosopher whose motto was, "I think, therefore I am," and who believed in a rational world governed by reason and mathematical design.

It is said that Descartes conceived his method of coordinates one day while lying in bed watching a fly crawl across the ceiling. He was able to imagine the ceiling converted into a graph consisting of parallel and perpendicular lines, bounded on the left side and the bottom by two right-angled legs, or axes, which he designated as x and y. With this tool, he could plot, numerically, every point along the insect's wandering track across the ceiling by reference to its right-angle measurements from these two lines.

Building on his original concept, "Cartesian Coordinates" came to be constructed with three perpendicular straight lines or axes, in which the lines x and y are on a horizontal plane, z is vertical, and all three are perpendicular to each other. Thus, any spatial point in the space defined by these lines can be pinpointed by right-angle measurements from points of positive numbers along each of the lines, the accuracy depending upon the precision of measurement. (Illustration 17)

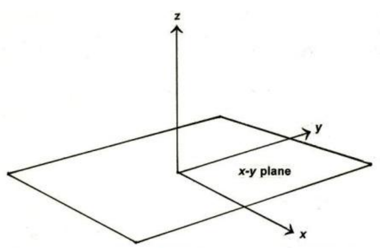

Illustration 17

However, since this illustration defines only one quadrant, it becomes necessary to resort to negative numbers if points are to be defined in the other seven quadrants of a Cartesian cube. This is done by extending each axis through the center and by labeling points on its inverse axis with negative numbers.

In Illustration 18, the addition of -x, -y, and -z produces a three-dimensional geometric model that can be used to measure and plot any object of study, including Descartes' fly, should it take wing and fly into the next room, out the window, or to the moon.

However, its usefulness is plagued by the practical difficulty of contending with the negative or inverse numbers that necessarily enter the equation when one strays from the positive x,y,z quadrant. Moreover, there were the mysterious rules required to mathematically manipulate negative numbers generally, and imaginary concepts, such as the square root of negative one, specifically, for them to fathom.

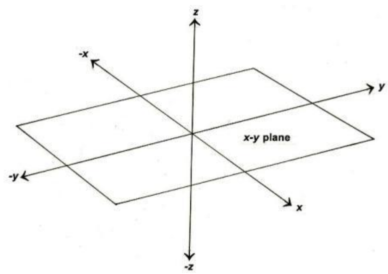

Illustration 18

Cartesian Coordinates also provide the ability to use "polar coordinates" to locate any point P on a plane by reference to its distance from three axes by a numerically rigorous process. We can simplify the effort in plotting points by reference to the length of a line (r) connecting the point (p) and 0 and by the angle (θ) between the line and any one Cartesian axis, such as x or y. (Illustration 19)

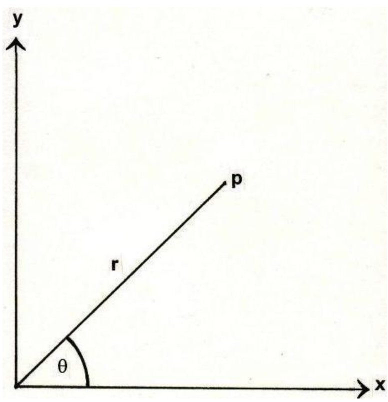

Illustration 19

Isaac Newton was later to mention polar coordinates as one of eight different coordination systems which could be used to define spiral curves, and Jakob Bernoulli (1654-1705) relied upon them extensively in determining the nature of many different curves.

Today, many applications, such as air traffic control radar, make use of polar coordinates; however, they must always be anchored to a numerically rational system of Cartesian coordinates.

ANCIENT MATHEMATICS

It is quite possible that genetically, within all living creatures, is an inherent or instinctive sense of numbers or counting. Experiments done with animals show that a female mammal appears to be constantly aware of the exact number of her children and will quickly begin to search for one that is missing. On a more primitive level, some birds will voluntarily abandon their nest if the number of eggs is reduced below a certain minimum number required for survival.

More basically, we find within all elementary mass, however identified, recurring numerical sequences, whether it is the atomic numbers of the chemical elements, the seeds of a sunflower, the spirals of a pine cone, or the radii of a snowflake.

A Last Voyage With the Ancient Mariners

Before navigating the shoals of mathematics, it seems essential to rest at anchor for a moment and to reflect upon several additional geometric mysteries, the better to chart the shoreline which joins the sea of geometry with the land of mathematics.

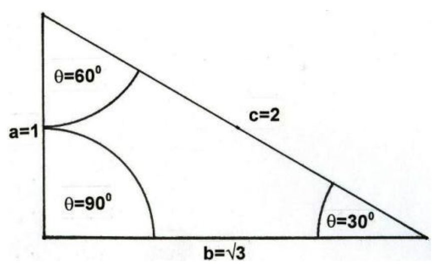

Illustration 20

The great value of the right-angle theorem and the reason for using it to construct the Khafre pyramid can be traced to the need of the ancients to chart the heavens accurately for purposes of navigation and to survey the land of their new colonies for settlement and cultivation. To accomplish this task, the ancients used elementary trigonometry, which is a computing tool that advances beyond the right-angle theorem.

Trigonometry uses the internal angles of a right-angle triangle to determine the ratios of the lengths of its sides, and is founded on the fact that the internal angles of all flat triangles always equal a total of 180º.

For example, in the simple 1:√3:2, or 90º:60º:30º, right-angle triangle shown in Illustration 20, the length of the leg (a) opposite the 30º angle is half the length of the hypotenuse (c), and the length of the leg (b) opposite the 60º angle is √3 times the length of the other leg (a).

These fixed proportions of length to degree of angle are the basis of the trigonometric functions and allowed the ancient mariners to calculate their position relative to the equator by the angle of the horizon to the Sun, Moon, and certain known stars.

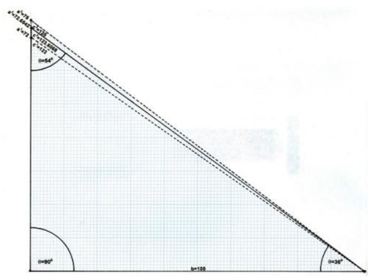

Illustration 21

The ancients used a special right-angle triangle, based on the Golden Proportion and known to them as *mr*, to calculate the value of angles used in basic trigonometry. The exact *mr* was constructed with a side of 72.6542, a base of 100, and a hypotenuse of 123.6068 (2/*Phi* x 100), producing a 36º angle between the hypotenuse and the base leg and a 54º angle between the hypotenuse and the side.

The *mr* was approximated with a triangle of 72:100:123, and, in a further simplification, the same approximate angles are produced by the basic 3:4:5 right-angle triangle, that can be enlarged 25 times to 75:100:125. (Illustration 21)[78]

[78] In addition to the data and drawings depicted in Illustrations 20 through 23, one of the great services provided by Peter Tompkins in his *Secrets of the Great Pyramid* is a book-length appendix, *Notes on the Relation of Ancient Measures to the Great Pyramid*

In the first approximate *mr*, the side opposite the 36º was found to be 72, that allowed the calculation of the trigonometric functions of all half-degree angles between 0º and 36º. Then, since 36º is 2/5 of a right angle of 90º, and is 1/10 of a full circle of 360º, *mr* allowed the calculation of the trigonometric functions for all angles.

It was for this reason that the ancients considered the *mr* triangle to be the basic element of the cosmos, and perhaps why one of the ancient names of Egypt was *To-Mera*, or the land of the *mr*.

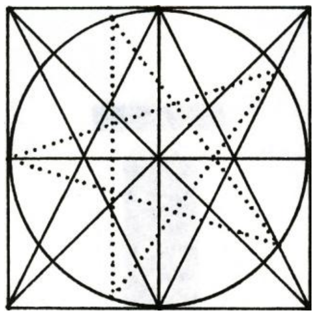

Illustration 22

Another geometric calculating tool used by the ancients was a drawing of a circle within a square, which was divided into four parts by a cross, or "+." Next, by constructing diagonals, they were able to inscribe within the circle the figures of a pentagon, hexagon, octagon and decagon. (Illustration 22)

The most useful of these inscribed polygons as a calculator was the pentagon, which defined a five-pointed star. The importance of this polygon, which represented the ancient number 23 and which was adopted by the Pythagoreans as the symbol of the initiated, was based upon the fact that it automatically divides the lines it crosses into their golden proportions.

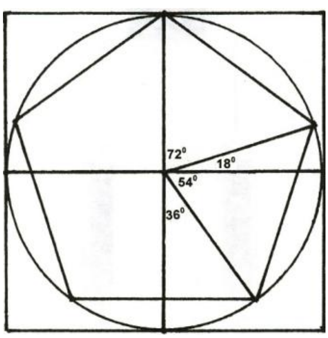

Illustration 23

Finally, by using the pentagon inscribed inside a circle, the ancients may have been able to observe and measure the irrational sums of √2, √3, and √5, as well as their multiples and fractions without arithmetical computations. (Illustration 23)

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by Livio Catullo Stecchini, from which information on the *mr* and other measurements was derived.

The pentagon also allowed the calculation of the basic trigonometric functions in the same manner as the *mr* triangle to demonstrate Sin 18º = 1/2*Phi*, Sec 36º = 2/*Phi*, Sin 54º = *Phi*/2, and Sec 72º = 2*Phi*.[79]

Evidence that the ancients were familiar with trigonometric functions can be found in problem 56 of the Rhind Papyrus that asks, "If a pyramid is 250 cubits high and the side of its base 360 cubits long, what is its *seked*?"

From an analysis of the problem we learn that the seked is the cotangent of the angle between the base of the pyramid and its face. In other words, it is the ratio of half the side of the base of the pyramid to its height, or the run-to-rise ratio of its face.

This problem demonstrates that it was no accident that the ancient Egyptians were able to maintain a constant slope of each pyramid face relative to the horizon. This knowledge allowed the builders to constantly check their progress to ensure that the required slope was maintained and that the seked was the same for each of the faces.[80]

The First Calculators

During the last century, as archeology has advanced to a science and the centers of ancient civilizations have been subjected to systematic excavations, we have found many references to incredibly large numbers among the ruins. Mostly, these numbers have been associated with calendar functions as they seem to record the dates and frequencies of various phenomena, such as the period of

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[79] In trigonometry, "Sec" designates secant, which is the function that, for an acute angle, is the ratio of the hypotenuse of a right triangle of which the angle is considered part and the side adjacent to the angle. "Sin" designates sine, which is the function that, for an acute angle, is the ratio between the side opposite the angle when it is considered part of a right triangle and the hypotenuse. (Webster's New Collegiate Dictionary).

[80] Maor, Eli. *Trigonometric Delights*, (Princeton University Press, 1998), p. 6. (Another delightful book by Professor Maor.)

revolution and conjunctions of the planets, and to reconcile these observations with the periodicity of the earth's movement.

Found carved in stone among the Mayan ruins are huge numbers going back more than 403 million years, and found stamped in clay on cuneiform tablets found in Iraq are tables of numbers representing a span of 6,200,000 years, expressed in seconds. Most interestingly, the most ancient data are also the most accurate.

We do not know for sure how the ancients arrived at these numbers, for we have only the results, but we do know they must have employed a fairly sophisticated system of mathematical calculation.

A cuneiform tablet recovered in 1854 at Senkereh, Iraq (near ancient Babylon), and dated between 2300 and 1600 B.C.E. records a list of numbers and their squares in an adjacent column. To derive these accurate results, it is likely the ancients used a form of counting that relies on an abacus, which is a flat board, table, or any surface on which is drawn horizontal lines representing ascending fractions, one, and multiples of one, and which can be divided down the middle by a vertical line.

The word *abacus* is Latin and may have been derived from the Greek word *abax*, that means a "flat surface" or from the Hebrew word *avak*, meaning dust. "Counters," such as small pebbles, were used on the abacus to represent numbers. The Latin word later used to designate these counters was *calculus*, meaning a small *calx*, the word for limestone, from which they were often manufactured.[81]

Counters have been found in excavations at Jericho and Gezer in Israel, and at ancient Kish in Iraq. Additional evidence for the early use of the abacus can also be found in the Americas, where native Indians were found to use pebbles for counting, and in Mayan ruins

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[81] Pullan, J. M., *The History of the Abacus,* (Frederick A. Praeger, Inc., Publishers, 1969).

where kernels of corn were found strung in groups of ten on parallel strings.

The earliest evidence of the use of calculators by the ancient Egyptians is recorded on several papyri, one of which has been dated to about 1500 B.C.E. It shows a grid of 100 dots arranged in ten rows, divided by a horizontal line halfway down. The grid may have served a calculating function, for we know the later Egyptians used the abacus, since it was commented upon by the Greek historian Herodotus, who noted that the Egyptians counted by pebbles in a manner opposite to the Greeks.

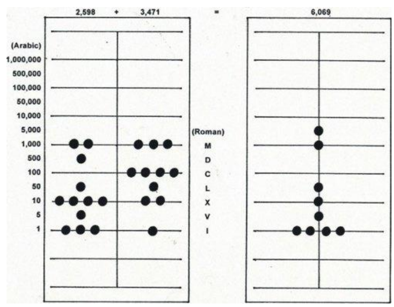


Illustration 24

Numbers were designated by placing counters on the various horizontal lines to represent their subdivisions and fractional parts. To solve problems in addition, the second number was represented on the other side of the vertical line in the same manner as the first, and the counters of differing values were then moved together to the center on their respective horizontal lines.

Once the number of counters on any horizontal line totaled five, they were removed from the board, and one counter was placed above the line. When there were ten (one above the line and five on it), the counters were removed, and one was placed on the line above. Illustration 24 represents the addition of 2,598 and 3,471 for a total of 6,069.

Subtraction was performed in the reverse manner as addition, division involved repeated subtraction, and multiplication was performed by repeated addition.

The modern abacus, known in Chinese as a *suanpan* and in Japanese as a *soroban*, was derived from Western civilization and did not come into popular use in Asia until the Seventeenth Century. Its function is similar to the ancient abacus; however, sliding beads are used instead of counters.

The classical Greeks considered mathematics to be secondary in importance to geometry, largely because the geometric proofs derived were self-evident and did not always require mathematical notations. For these reasons, and because the abacus and counters were in common use, Greek scholars found it relatively easy to perform most necessary calculations.

For all their brilliance in geometry, the Greeks did not advance mathematics much beyond the fractions and abacus acquired from the Egyptians. As did the Hebrews and others, the Greeks interchanged letters of their written alphabet for the expression of common whole numbers. These symbols were used, over and over, in increasingly complex fractions to prove their observations.

It appears, however, that the ancients may have earlier solved many of the mysteries of mathematics, as well as those of geometry, which knowledge was either lost before the arrival of the Greeks, or that the Greeks failed to comprehend fully.

The Ruler of the Earth

A numbering system can be established with any base, with the number ten being the common, or decimal base we use today in ordinary transactions, and two, or plus and minus, as the binary base for computer or electronic calculations.

Irrespective of base, there are various progressions of numbers that have a logical internal relationship. One such series is known as perfect numbers, in which the sum of their proper divisors is equal to the number itself. The first of these (excluding one itself) is six, in which 1+2+3=6, and the second is 28, in which 1+2+4+7+14=28.

Using the perfect numbers of six and 28, the ancients were able to derive a set of numbers they used to construct their standards of linear measurement, or rulers. They started with one hand (75 mm) divided into four fingers (18.75 mm each) and joined four hands of 16 fingers into a "foot" (300 mm). One-and-one-half "feet" were then joined to construct a "yard," or cubit consisting of six hands of 24 fingers (450 mm), that was the common cubit of the ancient world. (Illustration 25)

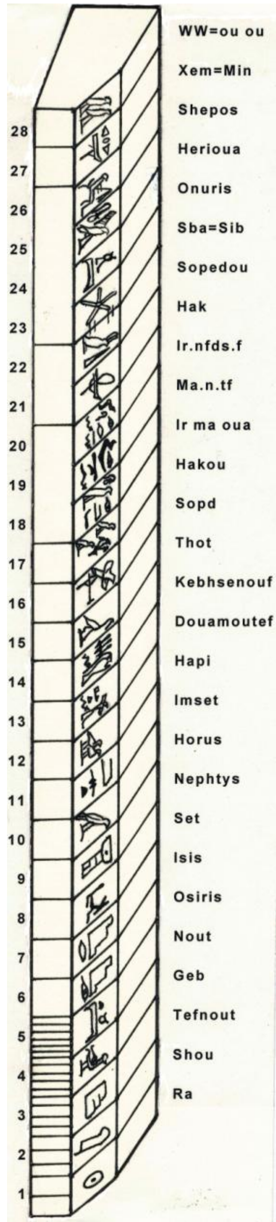


Illustration 25

Finally, the ancients added another hand of four fingers to the common cubit to complete the sacred cubit consisting of seven hands and 28 fingers (525 mm). Five of the 28 fingers could be further subdivided into fractional parts from ½ to 1/6. These graduations allowed for the accurate measurement of any line segment encountered in practical applications.

The value of this numbering system was that it allowed for the practical computation of most problems that confronted the ancient surveyors, such as the need to double or divide various plots of land in half. Thus, for them, the area of a square with a side of 70 was half of a square with a side of 100, that was half of a square with a side of 140. Under this system, the diagonal of a square was both 10/7 and 14/10 of the side.

This produced an approximate value for the square root of two ($\sqrt{2}$) as between 1.42857 and 1.4; however, when greater accuracy was required, they simply averaged the two results, (1.42857+1.4)/2, to arrive at the fairly accurate figure of 1.41428.

Moreover, as we earlier found, the fraction 22/7 provides a workable value of 3.142857 for *Pi*, the fraction 14/11 provides an approximate value of the square root of the Golden Proportion (√*Phi*), 1.272727, and 196 (142) divided by 121 (112) results in a close approximation of the Golden Proportion.

Each of the first 28 numbers was associated with a particular god, demigod, or ancient leader. Thus, one was Ra, designated by a circle with a dot; four was *Geb*, represented by a duck; six was *Osiris*, represented by half of a three-step ziggurat with a dotted eye under it; seven was *Isis*, represented the same as six except that the eye does not have a dot; 10 was *Horus*, represented by a falcon; 12 was *Hapi*, represented by two ducks; 23 was *Sba-Sib*, represented by a five pointed star; and 28 was *ou-ou*, or WW, represented by two falcons.

This system of calculating provided the ancients with the mathematical ability to measure the earth, which they did to a degree of accuracy not achieved again until the time of Newton.

The Girdling of the Globe

Beginning with the perfect number six, the ancients divided the period of a single rotation of the earth into two halves (night and day) of 12 (two times six) hours, for a total of 24 hours. Each hour was then divided into sixty (ten times six) minutes, which were each divided into sixty seconds, for a total of 86,400 seconds per day.

The circumference of the earth was then divided into 360 (62x10) degrees, each of which could be further subdivided by 60's into minutes (') and seconds (“) of arc for a total of 1,296,000 linear elements of curved geographical measure.

These two sets of measurement allow for the calculation of the amount of time it takes for a single degree along the equator to move past or under the sun. Thus, a geographical degree (1^0) is equal to four minutes of time, and a minute (1') of geographical degree is equal to four seconds of time. Conversely, a minute or second of time is equal to 15 minutes (15') or 15 seconds (15”) of one geographical degree.

This use of 60 and its multiples by the ancients is known as the sexagesimal (base-60) system.

With these tools, the ancients were able to girdle the globe by a series of lines, or chords, that divided its surface into 360 longitudes running north and south and 180 latitudes running east and west. This method provides a grid of 64,800 polygons, which are nearly square at the equator, but which become triangles where they come together at the poles.

When the modern system was adopted using the ancient coordinates in the time of Newton, England ruled the seas and possessed the only accurate chronometers. Therefore, the prime meridian of 0º longitude was made to run through the observatory at Greenwich, from which we get Greenwich Mean Time.

The set of modern longitudes extends both east and west from Greenwich, usually in 15º increments, to the opposite side of the earth where the international date line is located at 180º between east 165º and west 165º longitude.

Latitudes were defined as perpendicular to the longitudes, extending up and down from the equator to north and south 90º latitudes, which are the north and south poles.

In addition, the latitude of 23º27' north is known as the Tropic of Cancer, and 23º27' south is the Tropic of Capricorn. At the tropics, the sun shines perpendicularly on the longest days of the year, or summer solstices, in each hemisphere.

At the equator, the sun's rays are perpendicular on the spring and fall equinoxes, at which time the night and day are equal.

The ancients constructed the Great Pyramid at the intersection of the longitude and latitude that crosses the greatest amount of land mass on Earth. They established their prime meridian through the center of Egypt and the pyramids, perpendicular to the equator, and deduced the lengths of the latitudes and longitudes.

To do so they may have established an observatory slightly north of the Tropic of Cancer on the island of Elephantine at the southern border of Egypt. The island may have contained a deep well, from the bottom of which the edge of the sun could be seen at midday on the summer solstice to fully illuminate the well without shadow.

In addition, by the construction of sight lines within the pyramids, they may have been able to accurately measure the transit of significant stars. By their use of the Great Pyramid and obelisks as sun clocks, they could calculate precisely the exact length of the day and year. From all this, they were able to calculate a precise geographical cubit of 0.4618 meter, slightly longer than the sacred cubit of 0.450 meter.

An Astronomical Calculator

The ground plan of the three pyramids maps the relationship of the three main belt stars of the constellation Orion and the "Milky Way" to the pyramids and the Nile river. The word Orion is derived from Sah for Osiris, "The Lord of the South."

Because of its own unique proper motion, Sirius (the "Dog Star" following at the heels of the great hunter, Orion) appears in the east at dawn each year, almost exactly 365.25 days after the previous rising.

Sirius is not only the brightest star in the heavens, but it is the only star possessing the requisite proper motion to coincide with the solar year (measured between equinoxes) of 365.2242 days. However, because of the precession of the equinoxes, Sirius, along with all other heavenly objects, also rises 20 minutes later than the year before, in what is known as the sidereal year of 365.5636 days.

The ancients may have built the Great Pyramid to represent a scale model of the northern hemisphere of the earth and to record permanently both their methods and measurements. At midday on the spring equinox the sun can still be observed to "swallow" its shadow on the north face of the Great Pyramid at the moment the angle of the sun becomes parallel to the angle of the face along its apothem.

Extending to the north was a smooth pavement constructed with a pattern of stones that allowed for the precise measurement of the sun's shadow, and extending to the south was a similar pavement allowing for the measurement of the sun's reflection from the pyramid's original highly polished surface.

The Hellenistic Greek, Agatharchides of Cnidus (? - ca. 150 B.C.E.), served as a guardian of the king of Egypt in the Second Century B.C.E. He recorded that the length of one side of the Great Pyramid base was intended to represent 1/8 minute of degree, and the apothem was equal to 1/10 of a minute of degree.

When measured by the geographical cubit, one side of the pyramid base is equal to 500 geographical cubits, and the apothem is equal to 400 geographical cubits. Thus, 500 times eight equals a minute of arc, 500 times 60 equals a degree, and 500 times 360 equals 86,400,000.

Since there are 86,400 seconds in a day, the distance traveled by the spinning earth at the equator each second is exactly 1,000 geographical cubits, or slightly more than 1,000 miles per hour.

The importance and validity of the ancient legends conforming the proportions of the Great Pyramid to the earth was later recognized in the Seventeenth Century by Isaac Newton, who had to delay the publication of his general theory of gravity until he could obtain accurate measurements of the earth.

John Greaves (1602-1652) measured the Great Pyramid's dimensions in 1638, and using Greaves' data, Newton deduced that the pyramid had been built on the basis of two different cubits. The “profane” cubit of 20.63 inches (450 mm) resulted in the 10x20 cubit King's chamber, and the “sacred” cubit (between 24.80 and 25.02 inches, or 525 mm) which had been reported by Flavius Josephus (37- ca. 101 C.E.) in describing the circumference of the pillars of the Israelite Temple in Jerusalem.

Although Newton's conclusions regarding the lengths of the cubits were fairly accurate, his calculations of the size and volume of the earth were inaccurate, because Greaves was unable to get down to the base of the pyramid due to accumulated debris.

Newton had to wait until 1671 when the French astronomer Jean-Felix Picard (1620-1682) was finally able to measure a degree of latitude as approximately 69.1 English statute miles. From this, Newton was able to calculate the dimensions of the earth more accurately in arriving at his conclusions regarding its gravitational mass.

We can only imagine the effect on history if Greaves had been successful in obtaining the true measure of the Great Pyramid, and Newton had been able to more quickly publish his theory of gravitation and method of calculus. Human society could have gained an exponential thirty-year advantage, and we might have traveled to the moon by the beginning of this century, instead of fighting two destructive world wars and unnecessarily inventing nuclear weapons.

The circumference of the earth has been measured by modern satellites to be 24,902.45 miles; its polar radius is 3,949.921 miles. Multiplied by 5,280 (feet per mile), the circumference is 131,484,936 feet and the polar radius is 20,855,582.88 feet.

For convenience, using feet rather than meters, the circumference of the Great Pyramid is 3,023.16 feet and its height is 481.3949 feet. To determine the scale used by the ancients, we can divide the pyramid dimensions into the earth's measurements to arrive at a close approximation of 1:43,200.

The use of this scale could have hardly been accidental since 43,200 is not only one half of the number of seconds in a day, it is also directly related to the precession of the equinoxes.

Precession is based upon the fact that the polar axis of the earth slightly wobbles, which results in the sun rising on the spring, or vernal, equinox at a point in its house, or constellation, slightly behind where it was the year before. The movement is so slight as to be almost unnoticeable, amounting to about 1° every 72 years. Thus, it takes almost 2,160 years to move through the 30 degrees accorded to each of the 12 constellations of the zodiac, and 4,320 years to move through two. (*See above* Illustration 1)

While this in itself might be coincidental, the number 4,320, and its variations such as 432, 4320, 432,000 and 4,320,000, are found in the numbering systems and legends of all ancient civilizations, from the Mayans to the Hindus. It is the basic meter of time. According to the Mayan long count that began on August 13, 3114 B.C.E., the age in which we live was to have ended on December 23, 2012.[82] Fortunately, it did not.

A group of internally related numbers is known as the Fibonacci series and is attributed to Leonardo Bigollo Fibonacci (1170-1250), who is considered to be the greatest mathematician of the Middle Ages. He traveled with his father to Algiers, where he learned the Hindu system of numbers from the Muslims.

Later, in Egypt, Fibonacci learned the mysteries of the ancient numerical series in which each new number is the sum of the previous two. The series, 1+2+3+5+8+13+21+34+55+89+144 . . . results in the ratio between each successive number fairly quickly becoming equal to the Golden Proportion.

In addition, as we noted earlier, the ancients were aware of the secret "Templar" formula, *Phi*2 x 6/5 = *Pi*, that is a function of the Fibonacci series. First, each number in the series can be divided by the previous number to provide an approximation of the Golden Proportion, that becomes accurate to nine places at the 24th number of the series. Second, each number can be multiplied by 1.2 (6/5) and then divided by the second previous number to provide an approximation for *Pi*, that also achieves a limit of 3.141640787 at the 24th number of the series.

Fibonacci may not have been aware of the *Pi* function of the series, for in his *Practica Geometriae* published in 1220 C.E., he relied on the fraction 864/275 as an approximate value of 3.141818 for *Pi*,

[82] Hancock, Graham, op. cit.

even though it was slightly less accurate than that provided by his series.

A Fibonacci series can be commenced by any number. Thus, *Phi*+2*Phi*+3*Phi*+5*Phi*, or *Pi*+2*Pi*+3*Pi*+5*Pi*, or any other number can begin the series, that will arrive at the same limits as above at approximately the 24th operation.

Fibonacci is credited with introducing the modern decimal system to Europe, which was still struggling with Roman numerals and Greek letters. Although there is evidence the Hindus employed the first nine numbers as early as the Third Century B.C.E., the use of zero doesn't appear in the archeological record until the Ninth Century C.E.

The Hindus called the zero a *sunya*, meaning “empty,” and when the Arabs adopted the system, they called it a *sifr*, that became a *zefirum*, or “cipher.” It took hundreds of years before the Europeans fully accepted “Arabic” numbers, including the concept of zero.

The regular use of the abacus and counters continued into the Seventeenth and Eighteenth Centuries, and the British Exchequer didn't abandon the use of counters until 1826.

Although the Golden Proportion is an irrational number, it is not transcendental like *Pi* and *e*, and, therefore, can be represented algebraically. Symbolically, although it is numerically irrational, we can determine its supreme orderliness by noting that *Phi* (1.61803389) and its square (2.61803389) are both represented by the identical decimal expression. Not only is this true, but amazingly enough $Phi^2+Phi= Phi^3$, $Phi^3+Phi^2= Phi^4$, and $Phi^4+Phi^3= Phi^5$.

Numbers are magical. They have always been magical, and they will remain magical, everywhere and whenever there is something to be measured and counted, and there is someone to wonder what and why.

THE ENDING

At least, let us learn this from this little book: In the earliest time of human civilization—we lived in peace and our wisdom was profound. With the discovery of war and the resulting self destruction—we abused our knowledge and lost our way.

Just imagine where we would be today had our energy and resources been directed to peace and exploration, rather than war and conquest. We would be there looking back at here, rather than here looking out at there.

It is not too late to recover what has been lost, but time is short. As we rapidly exhaust the resources of the garden wherein we live, we must adapt or die. The choice is ours.

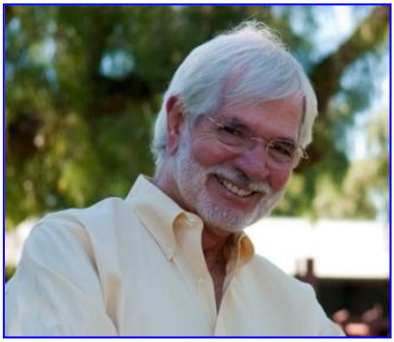
If we fail to act wisely and our light goes out, Mother Earth will spin on and, in just a few centuries, the rivers will once again run clean to the oceans.

After a galactic moment, another child will look up and will begin to count the cycles of the moon, note the solstices, chart the movement of the planets, and will dream of flying to the stars.

They will find the artifacts of our existence and will wonder what, when, and why.

WILLIAM JOHN COX

For more than 45 years, William John Cox has written extensively on law, politics, philosophy, and the human condition. During that time, he vigorously pursued a career in law enforcement, public policy, and the law.



As a police officer, he was an early leader in the "New Breed" movement to professionalize law enforcement. Cox wrote the *Policy Manual* of the Los Angeles Police Department and the introductory chapters of the *Police Task Force Report* of the National Advisory Commission on Criminal Justice Standards and Goals, which continues to define the role of the police in America.

As an attorney, Cox worked for the U.S. Department of Justice to implement national standards and goals, prosecuted cases for the Los Angeles County District Attorney's Office, and operated a public interest law practice primarily dedicated to the defense of young people.

He wrote notable law review articles and legal briefs in major cases, tried a number of jury trials and argued cases in the superior and appellate courts that made law.

Professionally, Cox volunteered *pro bono* services in several landmark legal cases. In 1979, he filed a class-action lawsuit on behalf of all citizens directly in the U.S. Supreme Court alleging that the government no longer represented the voters who elected it. As a remedy, Cox urged the Court to require national policy referendums to be held in conjunction with presidential elections.

In 1981, representing a Jewish survivor of Auschwitz, Cox investigated and successfully sued a group of radical right-wing organizations which denied the Holocaust. The case was the subject of the Turner Network Television motion picture, *Never Forget*.

Cox later represented a secret client and arranged the publication of almost 1,800 photographs of ancient manuscripts that had been kept from the public for more than 40 years. *A Facsimile Edition of the Dead Sea Scrolls* was published in November 1991. His role in that effort is described by historian Neil Asher Silberman in *The Hidden Scrolls: Christianity, Judaism, and the War for the Dead Sea Scrolls*.

Cox concluded his legal career as a Supervising Trial Counsel for the State Bar of California. There, he led a team of attorneys and investigators which prosecuted attorneys accused of serious misconduct and criminal gangs engaged in the illegal practice of law. He retired in 2007.

Continuing to concentrate on political and social issues since his retirement, Cox has lectured, taught classes at the university level, produced a series of articles and books, moderated several Internet websites and maintained an extensive worldwide correspondence. His primary initiative is the United States Voters' Rights Amendment (www.usvra.us and www.y4vra.org). He can be contacted through www.williamjohncox.com.

Author photograph by Catherine Diane Frost.