UNIFICATION SCIENCE

by Richard L. Lewis

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INTRODUCTION

The rapprochement of science and religion through Unification Thought (UT) is possible for these reasons:

1. UT states that God created in two steps: First step: was the creation of the Logos (a sophisticated abstract structure founded of the natural laws of science) modeled after the Human. Second step: God initiated the Big Bang which, step-by-step over billions of years, ended with the emergence of the first Humans. In contrast to UT and science, many believe that God directly creates things.

2. UT and quantum physics are in agreement that there an internal directive aspect to matter (called the wavefunction described with complex numbers) and a responsive external aspect. Furthermore, natural law—the simplest level of the Logos—only determines the internal aspect which projects externally as the probability of what happens externally. Natural law does not directly determine what happens.

3. In UT, the period between the creation of the Universe and the emergence of mature humans is called the indirect dominion. During this period, God does not directly work in the physical realm but only indirectly through the Logos. It is only through humans that God works directly; it is only through humans that God performs "miracles."

4. In UT, each step in the expression of the Logos comes on the foundation of what has already been established. UT is in accord with the Darwinian sequence of **what** happened in evolution. The main point of disagreement is **how**: Darwin settled for chance-and-accident, UT affirms that the Logos provides the appropriate laws at every level: biochemistry, biology, genetics, habitats, etc.

5. Almost all religious perspectives, including UT, state that physical matter is not all that there is. With the discovery that physical matter is only 5% of reality, there is clearly room for further rapprochement

This book will apply some of the insights from UT to aspects of modern science and see if this new perspective is a constructive one. The three topics are fundamental physics, the duality of analog form, and the possibility for interstellar and intergalactic travel.

BENT AND TWISTED SPACETIME

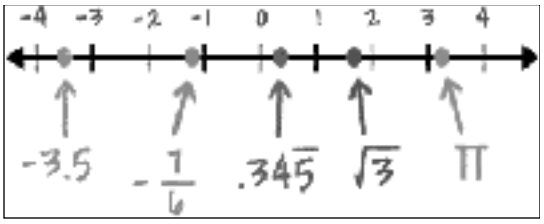
In classical physics—the one taught in High School—space is simple nothing while time is what keeps everything from happening all at once. It took the genius of Einstein to realize that space and time were inextricably linked together as a single entity—spacetime—and that movement in time and movement in space were just orthogonal components of movement through spacetime.

Rather counterintuitively, it turned out that everything is always traveling at lightspeed through spacetime, but the components could be radically different for different entities. For us sluggish humans hardly moving at all through space, all that tremendous velocity is mainly in the time dimension. To us, a single second seems trivial, but this is just the insensitivity of our time sense as compared to our sensitivity to space. In science, moving one second in the time dimension is equivalent to moving 186,000 miles in the space dimensions. I have just travelled 66 years through time since my birth, I have travelled the equivalent of four thousand trillion miles through spacetime! At the opposite extreme, a photon—a bit or quanta—of light travels at lightspeed through space and not at all through time. If a photon had senses, everything would seem to be happening all at the same time!

The mathematics that accurately describes this dereliction of common sense is just a sophisticated version of the Pythagorean theorem. In order to understand this, however, we need a little mathematical history, simplified for reasons of exposition.

Complex Numbers

The concept of the counting numbers, measuring the natural integers, such as one, two, three, etc. emerged in many cultures. The ability to cut a cake into two, lead to the concept of fractions, such as 1/2 and 1/3. The Greeks were aware, against their common sense, of irrational numbers such as $\sqrt{2}$ that had to exist but were not the ratio of two integers. Later, Hindu mathematicians made sense of Zero and negative numbers moving 180° in the opposite direction. Finally, the transcendental nature of numbers such as π, the ratio of circumference to diameter in a circle, and e the base of the natural logarithms, that involve infinity in their characterization, was understood. This history of innovation finally established what the mathematics call the real numbers, that stretch 2-dimensionally east and west from the zero point:

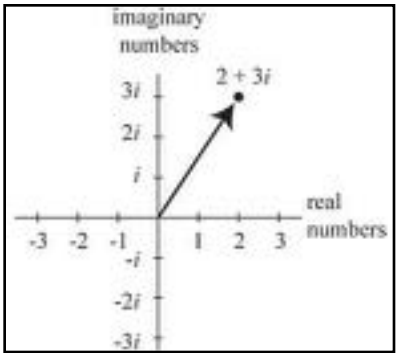


The real numbers are all about linear extension and size. Quite separate from this in High School math is rotation, where a complete rotation is 360° or 2π radians. In simple math, these two types of measure are considered quite separate; but Nature does not. To my mind, this is obvious when multiplying by –1. Consider a truly enormous number that extends way, way out along the east of the real number line, e.g. a google, 10100. Multiply this gargantuan eastern extension by the humble –1 and

it flips to a gargantuan western extension along the real number line. If restricted to the 1-D real line, it would seem that the giant number must shrink to zero then massively extend in the opposite direction. A transition state of zero, however, creates a multitude of problems, such as how is this transitional zero (which will massively extend west) different from the zero created by 1–1 which is quite quiescent? The solution was to consider –1 as an operator that rotates a number by 180° which avoids shrink and expanding a zero.

Admitting a rotation by 180° into the toolbox of math, however, allowed the possibility of rotating a number by 90° as well as by any angle from 0° to 360°. This was the birth of the imaginary numbers (90° rotation) and the complex numbers with both an arbitrary linear magnitude, M from 0 to ∞, and an angle of rotation, A from 0° to 360°, 0 to 2π radians. The 90° rotation operator was given the symbol i and, just as 90°+90° is 180° this also symbolizes the square root of –1, i2 = –1. With these operators, the great conundrum of High School mathematics—"minus times minus is a plus, for reasons we need not discuss"—makes sense as 180° + 180° = 360° = rotation back to zero rotation.

This extension of the realm of numbers solved many problems in mathematics, and as natural phenomena almost always involve both linear and angular changes, complex numbers have become essential in the scientific description of reality. A complex number on the complex plane is usually illustrated as an Argand diagram, a 2-D diagram of an essentially 1-D number, where the E-W line is real while the N-S line is imaginary.



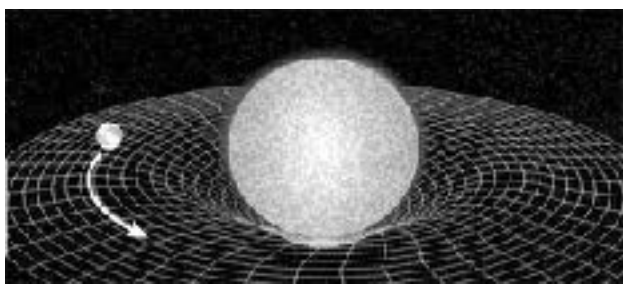
Just as the real line is a great aid in understanding regular numbers, the complex plane with orthogonal real and imaginary axes is an aid in understanding complex numbers. Complex numbers can be expressed in a rectangular form [z=x+yi], in a polar form [z=r(cos θ +i sin θ)], or in an exponential form [z=reiθ], All being the identical number.

Curved Spacetime

While space and time might be related, they are clearly different. This difference was eventually mathematically codified by time being a real component of spacetime, while the components of space are imaginary components. Mathematically, spacetime has 4 components, t, xi, yi, zi, and squaring this in the Pythagorean relation give the metric, the measure of distance in spacetime, d. While it might seem that space is more real than time, +1 and –1 are very different while ±i are just a matter of clockwise or anticlockwise rotation. This is like spacetime—going forward or backward in time is radically different, while going up or down is just a point-of-view.

$$d = \sqrt{t^2 - x^2 - y^2 - z^2}$$

While it impossible to bend a line in one dimension—bend it where?—it is possible to bend a line traversing a 2-D plane. It was allowing spacetime dimensions to be complex rather than real that allowed Einstein to consider the concept of spacetime being curved and a new view of gravity to emerge. In this new view, gravitational attraction was replaced by



movement in curved spacetime. The Sun is not attracting the Earth by force, rather the Earth is always moving straight ahead but in the curved spacetime dented by the Sun.

The concept of bent spacetime is now mainstream physics. On this basis, we will consider the possibility that if spacetime can be bent on the macro scale, then we can consider the possibility that can be twisted on the micro scale.

Twisted Spacetime

While gravity seems all-powerful in everyday life and in astronomer's descriptions of gravity's role in stars, black holes, galaxies, etc. it is solely because massive amounts of matter are involved. While gravity is preeminent on a macro scale, it is so feeble on a micro-scale that it can be ignored when discussing minuscule entities such as a single atom. While scientists have been humbled to discover that familiar matter makes up only 5% of the universe—the other 95% is still a mystery—they have made great strides in characterizing the familiar, if minor, stuff.

This familiar matter is ruled by four fundamental forces: gravity that we just discussed, and three quantum forces, two which rule the subatomic realm—the Strong and Weak nuclear forces—and the familiar Electromagnetic force. The table lists the relative strengths of the four forces.

Force	Strength
Strong	**1**
Electromagnetic	**10^{-2}**
Weak	**10^{-13}**
Gravity	**10^{-38}**

Einstein also established two basic principles:
1. Matter is concentrated energy
2. Energy is quantized, it comes in discrete packets called quanta.

The familiar world involves just two types of basic quanta, called fermions and bosons. In the vernacular, fermions can be considered the 'quanta of matter' while bosons are the 'quanta of force.' The electron is a fermion while a photon of light is a boson. The defining difference between the two kinds involves rotation and spin. Rotate a boson by 360° and its spin is unchanged; rotate a fermion by 360° and it spin will be opposite to the start, it takes another 360° rotation to return it to its original state. Technically stated, bosons have an symmetrical integer spin of 1, while fermions have an asymmetrical fractional spin of 1/2.

This two types of spin determines the two contrasting characters of bosons and fermions. Bosons are convivial and readily congregate with each other in the same state. The laser is as example where billions of photons merge into a single state. Fermions are the opposite being so hostile that it is impossible for them to share a state with others except one with the opposite spin. The electronic structure of orbital pairs underlying the Periodic Table of the elements is an micro example of this fermionic exclusion principle. A macro example is a White Dwarf, the dotage of our Sun, held up against gravity not by temperature but by its electrons refusing to share the same state.

Ignoring gravity as it stand alone, there is a mysterious numerological connection with the number 3 in the known fundamental entities of nature:

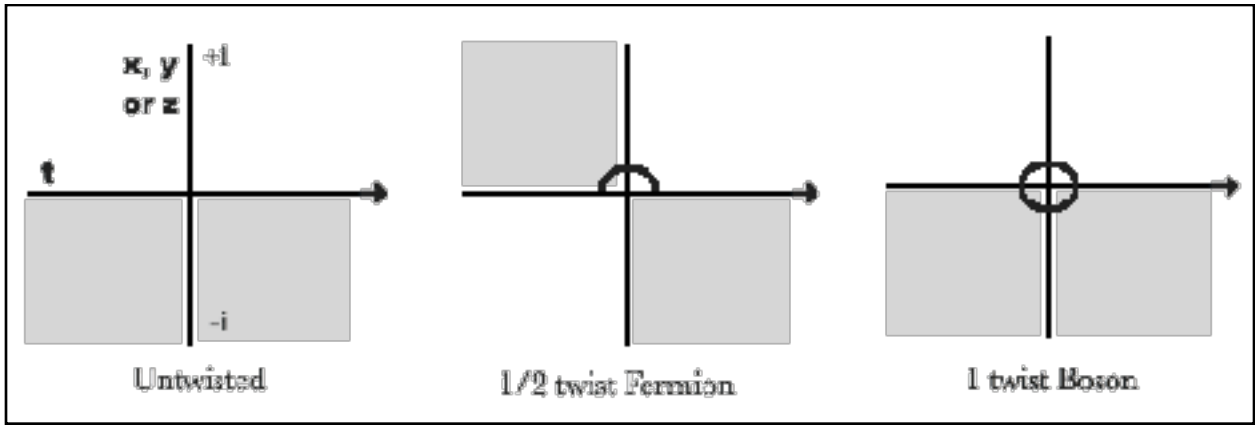
1. There are 3 quantum forces, the weak, the electromagnetic, and the strong. and correspondingly 3 types of symmetrical boson: the Z,[1] the photon, the gluon.

2. There are 3 types of asymmetrical fermion: the neutrino, the electron, the quark. When "going the there way" in spacetime they are: the antineutrino, the antielectron, the antiquark.

3. There are 3 generations of increasing mass/energy for each fermion: the electron generation, the muon generation, the tauon generation (each having an antimatter partner)

4. There are 3 quantum color-charges[2] that quarks can have, called R, G, B. There are 3 anticolors that gluons and antiquarks have, –R, –G, –B (called C, M, Y in color ink cartridges).

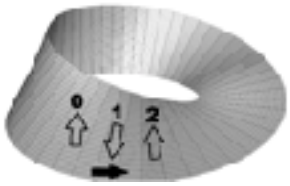
In the view presented here, this emphasis on 3 in the basic entities of nature is a consequence of all the basic entities being twists in the 3 spatial components of spacetime.



Oriented, Nonoriented Twists

Topology is that branch of mathematics classifying geometric properties and spatial relations unaffected by the continuous change of shape or size of figures. In topology, a cup and a doughnut are alike as one can be transformed into the other by stretching and squeezing but not cutting or tearing.

A simple strip of transparent plastic can become a topological exemplar by twisting one end 180° before sealing the ends together to create a Moebius strip. While the original strip had two distinct sides, the Moebius has just one. An arrow pointing up becomes an arrow pointing down after one circuit, and only regains its original orientation after two rotations. For this reason, the Moebius is called a nonoriented surface. As the 1/2 twist creating the strip can be either clockwise or anticlockwise, a Moebius comes in two mirror forms, a left- or right-handed non-oriented strip so



[1] The massive Z is electrically neutral, the W's are charged and are less massive resonances of the Z, as will later be discussed

[2] The red, green and blue charge on quarks has nothing to do with visual colors, but as we sill see, they do have similar dynamics.

combining the two results in an untwisted state.

If, however, the original strip was twisted by 360° before sealing, the arrow would remain unchanged after just one circuit of the strip. This twist generates an oriented surface.

The 180° twist of the non-oriented Mobius is akin to fermion behavior, while the 360° oriented twist is akin to boson behavior. Such twists in the spatial components about the time component could be the reality of the fundamental bosons and fermions.

Moreover, as there are 3 spatial components, we can have 1, 2 or 3 twists. If so we have the following pattern of bosons:

1 symmetrical oriented twist: the Z boson

2 symmetrical oriented twists: the photon

3 symmetrical oriented twists: the gluon

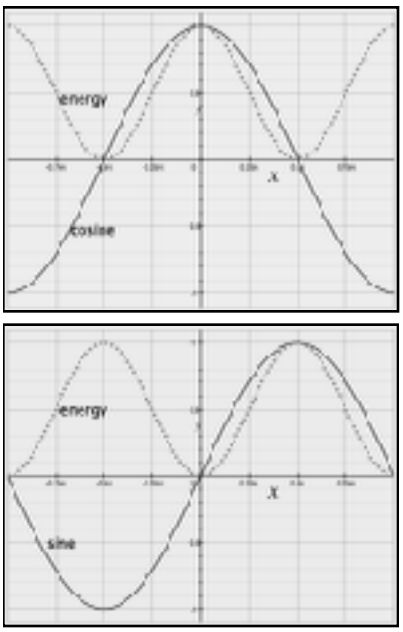
Being symmetrical, bosons going in the opposite direction along the complex time component are identical.

The pattern for the fermions is similar except, being asymmetrical, going in the opposite direction along the complex time generates antimatter: It has been established that the 1/2 twists in fermions is left handed, while that in anti-fermions is right handed. When matter and antimatter meet, the non-oriented state disappears and oriented bosons carry away the energy dissipated.

1 asymmetrical nonoriented twist: the neutrino	going back, the antineutrino
2 asymmetrical nonoriented twists: the electron	going back, the antielectron
3 asymmetrical nonoriented twists: the quark	going back, the antiquark

Open and closed Waves

The polar form of complex numbers, $z=r(\cos \theta + i \sin \theta)$ expresses the wave-like nature of complex numbers and, by extension, complex dimensions. This wave-like aspect has important consequences for both bosons and fermions.



The two basic types are the sine wave and the cosine wave which oscillate from positive to negative amplitude. Like any wave, the intensity or energy of the wave is the square of the amplitude, which is always positive. As traveling waves, the sine and cosine waves are indistinguishable, just 90° out of phase with each other.

As bound or standing waves, however they are quite different as can be seen in the following diagrams. The cosine wave is symmetrical, with its energy located at the center and both boundaries.

Such energetic boundaries define the bounded cosine as an open wave.

The sine wave is asymmetrical with all its energy located in two lobes, and with zero energy at the center and both boundaries. The zero boundaries define the bounded sine as a closed wave.

Bosons and fermions have different types of wave, the symmetrical bosons are open cosine waves while the asymmetrical fermions are closed sine waves.

As can be imagined, the energetic boundary of a boson where the energy level has a vertical escarpment from high to low which creates tremendous stress on spacetime, and this stress can generate a great deal of energy. The boundary of a fermion, however, has no such problem as its boundary is already at zero energy.

This great disparity in energy is most obvious in the Z boson and the neutrino fermion that both involve the twisting of a single spatial component of spacetime. The closed wave of the neutrino gives it a mass so small that it has proven difficult to measure accurately, but it is probably around one millionth that of the electron. The open wave of the Z boson is creates such a stress on spacetime that it has a huge mass greater than 180,000 times that of an electron.

The Z boson has such a large energy that it has sufficient to generate and electron or positron, and the resultant resonant state, called a W± has lower energy, Z = 91 GeV, W± = 80 GeV.

The photon with two open waves might be expected to have more mass than the Z, but the quantum way with energy comes to the rescue. The electric energy is constantly transforming into magnetic energy, and vice versa. So either open wave is never around long enough to amount to a quanta of action. So efficient is this cyclical resonance that the photon is massless, its sole energy comes from its wave motion, its frequency. The magnetic 1/2 spin along the x axis, the electric 1/2 spin along the y axis, and the lightspeed translation along the z axis disturb spacetime not at all. The two orthogonal 1/2 spins of the electron disturbs spacetime enough that the stress energy is only ~0.5 MeV.

We will deal with the gluon shortly.

Scientific Existence

The philosopher Descartes' definition of existence— "I think, therefore I am"—might apply to humans but it is difficult to apply to electrons and the suchlike. The scientific measure of existence is called the action and is a measure of energy, E, in time, t; the action equals Et.

Rather counterintuitively (again), existence in science is not a smooth continuum but, like energy quanta, comes in secrete bits, the quanta of existence. In everyday units such as kilos, meters and seconds, these quanta are so tiny indeed— 6.6×10^{-34} Joules second—called Plank's Constant. Existence seems continuous to us only because the granularity is so imperceptibly small. This is analogous to water, which our coarse senses feel as smooth and continuous while oblivious to the inherent granularity of water molecules.

In the natural units often used in theoretical science—where the speed of light is 1—the unit of existence is also 1. If the energy-in-time of an entity $Et \geq 1$, the entity exists and is considered real; if it does not, the entity is not real but virtual, which makes a great deal of difference.

For once, common sense prevails in science, and light is definitely real in science. A photon of light has a real energy (which can suntan skin or turn it cancerous) and a period of time in which it makes a complete cycle of waving. This period of a wave is the inverse of the more familiar frequency—red light has a frequency of 400 trillion cycles/sec so its period is 1/400 trillionth of a second.

In fact, every photon of light has just one quanta of existence where, in the appropriate units, Et always equals 1. So, if the low energy of a red photon is E with a period of t, Et =1, then a blue photon with twice the energy, 2E, has half the period, 1/2t, and $2E \times t/2 = 1$. Photons of radio waves have tiny energy (E=10–6) and long periods (t=106) while those of gamma rays have huge energy (E=106) and minuscule periods (t=10–6), but in every case, $Et = 10–6 \times 106 = 1$.

This new, and highly-verified, view of real existence had decidedly non-classical consequences. One highly-valued precept in classical science was the law of conservation of mass/energy. The new view added the fine-print exception of mass/energy that did not amount to a quanta of existence. So energy, E, can appear out of nothing as long as it disappears in a brief enough time, t, so that $Et < 1$. So virtual bosons can appear and disappear as long as their $Et < 1$.

Fundamental Interactions

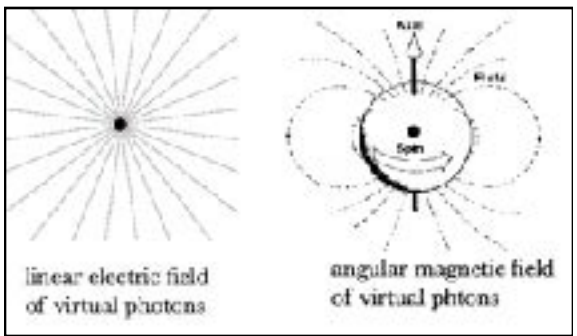
We earlier mentioned that bosons could be considered the quanta of force, but it is not real bosons that carry the three fundamental quantum forces, but virtual bosons:

Weak nuclear force— Z and $W^{\pm}$ bosons
Electromagnetic force— photons
Strong nuclear force— gluons

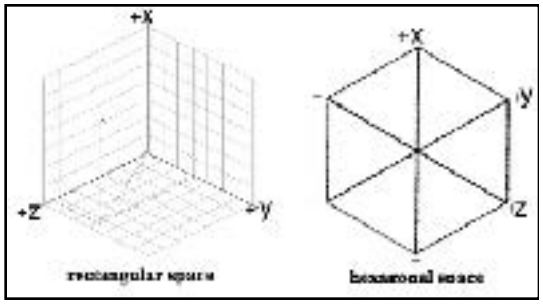
As bosons involve oriented twists, they can easily appear and disappear. Fermions, with their non-oriented twists are topologically stable. While bosons are truly elementary entries, the fermions are composite, being a real fermion and clouds of virtual bosons. This can be considered that the fermion jitter around attempting to ‘shake off’ the defect in spacetime by flinging off bosons.

The neutrino is enveloped in a cloud of Z and W± bosons. With such huge masses, their time of virtual existence is extremely short, so even at lightspeed they cannot get far before winking out, and the Weak interaction of fermions is very short range, about 10-18 meters which is about 0.1% of the diameter of a proton which, itself, is 1/10,000 the diameter of an atom. These virtual bosons can be exchanged with other fermions, they couple the Weak interaction, and the neutrino is said to have a Weak charge.

The electron also has such a halo of virtual Z and W bosons so can interact with a neutrino, as well as having a halo of virtual photons. Being massless and unmoving in the temporal coordinate of spacetime, there is no spatial



limitation and the density of these virtual photons falls of geometrically with the square of the distance. This is the electromagnetic field that surrounds an electron. The spin twist generates photons that have rotational motion—the magnetic field that departs via the N pole and returns via the S pole—while the other has a linear motion—the electric field that radiates outwards.



Overlapping fields of virtual photons with same polarity increase the density which pushes electrons apart. A positron has opposite polarity, so overlapping fields cancel and decrease the density, so electrons and positrons move towards each other. Like charges repel while opposite charges attract.

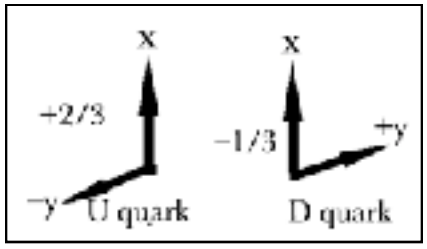
While virtual photons are unlike real photons they can be personally experienced by attempting to force the N poles of two strong magnets together. There is an invisible cushion that keeps the two apart no matter how strong you are. This is a direct experience of overlapping clouds of virtual photons.

The Weak and Electromagnetic are similar in that given sufficient energy, the coupling bosons, virtual Z/Ws and photons, can be made real and observed. This is not so for the Strong force where it is impossible to isolate single gluons, an absolute confinement that also applies to individual quarks, a confinement that distinguishes the Strong from the other quantum forces.

Confinement

The single 1/2 twist in the x^1 spacetime component of the neutrino hardly stresses spacetime at all (energy ~ 1 eV,) while the electron's 1/2 twist in the x axis, 1/2 twist in the y axis, and motion along the z axis does cause greater stress-energy (500,000 eV) it is achievable.

Adding a third 1/2 twist, however, creates such a great stress on spacetime that it is radically distorted—the three spatial components switch from a rectangular 3-D arrangement of 90° to a hexagonal 2-D arrangement of 60°—both arrangements still being orthogonal to the time component. As might be expected, this anomaly has to be contained and isolated to a very small volume so that its influence on the surrounding rectangular space is negligible.



The first spin axis (which we are labeling x) is not distorted, and this non-oriented twist is just like that of the neutrino and the electron. Only the y and z axes are distorted. The the non-oriented twist in second electric axis (which we are labeling y) has two possibilities 1. If it point along +y just like the electron, the quark has a –1/3 electric charge and the quark is called a D quark 2. If it points along the –y just like the positron it has a +2/3 electric charge and the quark is called a U quark. These are called quark flavors.

[1] It can be any one of the three but for the sake of clarity we'll call the spin x, the electric y, and the other z.

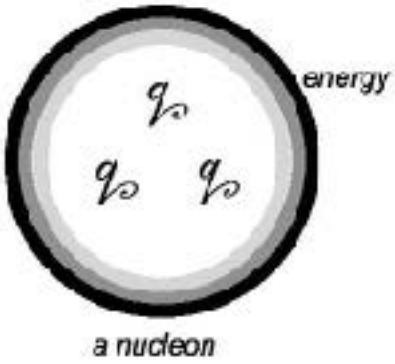
As there are actually three distinct choices for which axis will be the unchanged x spin axis, creating three different possibilities, labeled R, G, and B. These are the quark colors. Anti-quarks have anti-colors.

In the everyday world of color, there are the positive colors: the additive colors red, green and blue. These can be added to black (the RGB on a dark computer screen) to create all colors, and 100% of each generates white. There are also the anti-colors that subtract red—called cyan—subtract green—called magenta—or subtract blue—called yellow. These subtract color from white (the CMY[1] inks on printing paper) to create all colors, and 100% of each results in black. [One could call a anti-red quark a cyan quark but this has yet to catch on]

This hexagonal state is stressful, and the quark constantly attempt to rid itself of stress by shaking off gluons. While Z/W bosons and photons are complete-cycle cosine waves, a gluon is only a half-cycle standing wave with all its energy in the boundary and none in the center. At one end is a color and the other an anti-color.

I order to confine the hexagonal distortion, quarks are only found in colorless situations. The most usual combinations are the hadrons—three quarks together in a 'white' combination of R, G, B—and the pions—two quarks together in a 'black' combination of color and anti-color. In either situation, the hexagonal distortion is confined and can exist comfortably within rectangular space.

The stress-energy of the quarks is shed into the gluons, the energy of which creates the boundary where all the mass resides. The quarks at the colorless center now interact and arrange themselves by spin and electromagnetism. As protons and neutrons provide 99.99% the mass of the atoms of matter, the reality of mass is not a solid something but rather a high-energy shell composed of the energetic ends of gluons. The mosaic of this surface is composed of R,G,B,C,M,Y pixels and the overall effect is colorless and acceptable to rectangular space.



The two colorless hadrons of everyday matter are the proton and neutron. The proton quarks are UUD giving it an overall positive electric charge of +1, while the neutron quarks are UDD, giving it an overall electric charge of 0. For topological reasons that have yet to be explored, the U quark has slightly less energy than the D quark.

The result is that the neutron has slightly more energy (939.5 MeV) than the proton (938.2) which makes the isolated neutron unstable. If its quarks get close enough they can interact by coupling a virtual W flipping a D into a U and it becomes a proton and ejects an antineutrino and electron. This beta decay reflects the improbability of the weak coupling by having a half-life of 11 minutes, akin to eons on the usual timescale of nuclear processes.

The proton and neutron couple together by exchanging pions, creating the short-range strong force that holds a nucleus together against the long-range repulsion of the positive protons. This balance fails

[1] As the inks that subtract color are imperfect, a fourth black ink, K, is added, the CMYK process of color printing.

in large nuclei with more than 83 protons (bismuth) and all the elements beyond are unstable and radioactive albeit with a wide range of half-lives from minutes to billions of years.

Three Generations

The final example of the number 3 is to be found in the three generations of fermions as listed below. It is usual to call label each family by the central member—the electron family, the muon family, the tauon family. Only the 1st generation is found in everyday matter, the unstable 2nd and 3rd generations are created only in high-energy situations, such as the Large Hadron Collider (LHC) in Europe. There are also the anti-fermions twisted the opposite way, from the lightweight anti-e-neutrino to the massive anti-T-quark.

Generation	1 twist	2 twists	–1/3 3 twists +2/3	
1	e-neutrino	electron	D quark >	U quark
2	m-neutrino	muon	S quark <<	C quark
3	t-neutrino	tauon	B quark <<<	T quark

Each generation is based one 1/2-twist neutrino, extra non-oriented twists being added onto this base. It is possible for this first 1/2 twist to involve more than a single dimension, while the e-neutrino is a twist in 1 spatial dimension, the m-neutrino is a twist in 2 spatial dimensions, while the t-neutrino is a twist in all 3 spatial dimensions.

As can be imagined, all this puts extra stress on spacetime, especially the quarks. While it is difficult to separate out the rest mass-energy of a quark from the much greater energy of the gluons surrounding them, the T-quark is estimated to have 123,210 MeV of energy compared to the 2.3 of the U and the 4.8 of the D.

The Big Bang

The strict local confinement of hexagonal spacetime had a role in the creation of the matter in the universe. Unlike all the other three forces whose energy falls of with distance, the Strong force increases with distance, as might be expected if hexagonal space tries to invade rectangular space. This is why everyday confinement is so effective and isolated quarks or gluons impossible to observe. If for any reason a quark is impelled out of a nucleon, the energy rapidly rises to the point where a quark is created and it is a pion that is observed, not a single quark.

One scientific theory—and there are a few—is that the universe started with a Planck Length speck of False Vacuum (the Planck Length being the quantum of length at 10–33 meter). This was at the Planck Temperature (1032 °F, the maximum possible) filled with every kind of fundamental entity at an immense density.

This speck exponentially inflated, doubling in size every Planck Time (the Planck Time being the quantum of time at 10^{-44} seconds). The characteristic time of the Strong interaction is 10^{-28} seconds, the time frame of the interaction. While extremely rapid, it is 10^{15} Planck Times. The quarks and gluons in

$$1 \rightarrow 2^{10^{15}} = 10^{1\,000\,000\,000\,000}$$

the original speck will have their original separation almost instantly, on the Strong timescale, exponentially-expanded enormously.

The immensely-enormous energy generated by this vast separation crashed into the Hot Big Bang which, once all the antimatter generated had annihilated with matter (thankfully sparing a tiny fraction of excess matter for still unknown reasons) settled down after a few minutes to to a 100 billion parts photons, and one part electrons and nucleons. Presumably, at the same time, this familiar 5% was accompanied by the emergence of the 25% mysterious Dark Matter and the 70% doubly-mysterious Dark Energy. Eventually, 13.5 billion years later, here we are today.

EVOLUTION AND EPIGENETIC LEARNING

The current scientific theory of evolution is called the Modern Synthesis (MS) that unites Darwin's concept of survival of the fittest with the 'read-only' digital aspect of modern genetics. The MS combines the concept of random mutation that alters the DNA genotype that is expressed as random changes in the bodily phenotype, followed by natural selection of the fittest phenotypes to survive and reproduce.

In the MS, the randomly-altered digital information is expressed as altered analog forms. If a form happens to increase survival and procreation, the DNA enters the gene pool. If it does nothing, it also enters the pool. If it is deleterious, it is purged from the gene pool by the death or failure to reproduce.

To the modern mind, raised in an environment replete with digital computers, CDs, DVDs, smart phones etc., the concept of randomly-altering digital information and expecting any sort of constructive result is bizarre; all our experience of random digital information is that it leads to annoyance, vexation and a shopping spree for the latest version. As any programmer can attest, writing good code takes great skill and intelligence. Our experience in the computer realm is that the workings of a modern computer require that there be an ability to read and write digital information. Both being crucial to the sophisticated manipulation of information. The MS, however, only allows for reading digital information, it contains no concept of writing it.

Memory

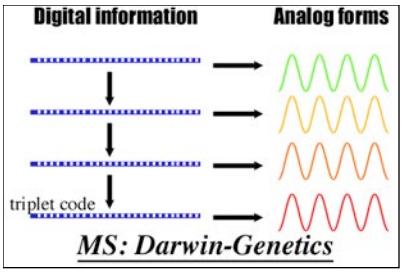
Active working
Short-term
Medium-term
Long-term

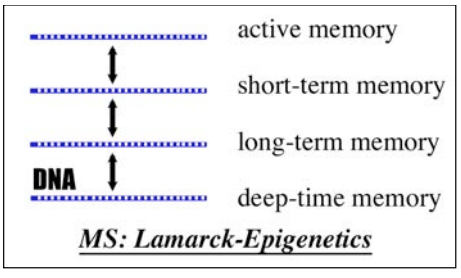
In Unification Thought, evolution occurs by learning aspects of the Logos, storing it as a memory and passing it on down a lineage. If the MS is epitomized by "random chance and survival of the fittest," this new view is encapsulated as "wisdom of the ancestors in expressing the Logos". This requires that both writing and reading are possible at every level.

While learning requires memory, memory does not imply learning. The computer is an example. It has a systematic hierarchy of memory, from active memory that is constantly changing, short-term memory in buffers and registers, medium-term memory in virtual disk images, and long-term memory when data is written to disk.

With this in mind, we can expect to find that living systems have various levels of memory from short-term active memory on RNA to deep-time storage on DNA. In the early days of evolutionary thought, Charles Darwin became associated with the concept of random variation underlying evolution, while Jean-Baptiste Lamarck was associated with accumulated learning underlying evolution. Lamarckism implies that writing to digital memory must exist alongside reading from digital memory.

While this writing to disk is absent in the Fundamental Dogma of genetics—information flows only from genome to phenotype—





the new and burgeoning science of epigenetics is explicitly exploring the writing of digital memory in living systems. In a unified science, the theory of evolution is a postmodern synthesis of Lamarck and epigenetics.

Epigenetics

While epigenetics is now so well-established as to have a recent Nova episode devoted to it on PBS television, it is probably a field that is unfamiliar to most people. In many ways, it can be considered the reemergence of Lamarckism in a much more sophisticated form:

> "For years, genes have been considered the one and only way biological traits could be passed down through generations of organisms. Not anymore. Increasingly, biologists are finding that non-genetic variation acquired during the life of an organism can sometimes be passed on to offspring—a phenomenon known as epigenetic inheritance. An article … in the July issue of *The Quarterly Review of Biology* lists over 100 well-documented cases of epigenetic inheritance between generations of organisms, and suggests that non-DNA inheritance happens much more often than scientists previously thought."[1]

The 'central dogma' of molecular biology is that there is a one-way flow of information from the genotype—the genes and DNA sequence—to the phenotype—the proteins and the result of protein action—i.e., the development and eventual form and function of the body. It is upon this central dogma that the whole of Darwinism is constructed since, as there is no 'back-flow' of information from the body to the genome, the only changes allowed in the genome are random mutations, random rearrangements, and other such random occurrences for natural selection to go to work on.

This dogmatic assertion, so fundamental to Darwinism, is clearly up for revision. Note that the preeminent proponent of materialistic Darwinism, Richard Dawkins, assumes in his many works that all is now understood of the basic principles of evolution premised on random mutation and variation.

As he does not, however, mention epigenetics even once in any of his writings, by this fact alone he is condemned to have only a partial view of the truth; the classic mistake of the blind man confusing his odiferous grasp of the elephant's tail with the whole beast. Richard Dawkins is not unique in this respect; this premature assumption of complete knowledge happened to many elder statesmen in physics just a century ago:

> "It seems that every so often, a fairly large group of scientists begin to assert that science is just about complete, that the vast unknown is gone, and that all the really major research can stop because we now know everything except the details. For those who fall under the spell of this sort of belief, be aware that a similar belief seemed to have taken hold at the turn of the last century. This was just before Relativity and Quantum Mechanics appeared on the scene and opened up new realms for exploration…. 'The more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted

[1] http://www.sciencedaily.com/releases/2009/05/090518111723.htm

in consequence of new discoveries is exceedingly remote.... Our future discoveries must be looked for in the sixth place of decimals.'[1]

"There is nothing new to be discovered in physics now. All that remains is more and more precise measurement" - *Lord Kelvin, 1900*."[2]

Just as in physics—where the advent of relativity and quantum mechanics punctured this 'we know it all' attitude—so the advent of epigenetics has the potential to puncture the biological 'we know it all' attitude prevalent in current Darwinism as exemplified by Richard Dawkins in all his writings. One can only feel sorry for Dawkins as the dustbin of history is not a comfortable place for one so arrogant.

The first hint that the one-way "central dogma" of Darwinism was wrong came when it was noticed that the identical genetic defect in the human genotype had very different effects on the phenotype depending on whether the faulty gene was inherited from the mother or the father.

Even though both parents contribute equally to the genetic content of their offspring, a developmental process called *genomic imprinting* sometimes leads to the exclusive expression of specific genes from only one parent. This process was first described in 1984, when two laboratories discovered a mark, or 'imprint,' that differentiates between certain genes on the maternal and paternal chromosomes and results in the expression of only one copy of those genes in the offspring. The genes in imprinted areas of an organism's genome are expressed depending on the parent of origin.[3]

This phenomenon was eventually traced to a pattern of chemical alterations—methylation of the cytosine bases—imprinted on the structure of the DNA. Here the DNA was acting as the substrate for a layer of information to be written on. This has nothing to do with the base sequence itself—the genetic code—it is defined as a level of epigenetic information impressed on the genetic level.

Epigenetics and Lamarckism

Even more dramatic examples that violated classical Darwinism were soon uncovered.

"Toward the end of World War II, a German-imposed food embargo in western Holland—a densely populated area already suffering from scarce food supplies, ruined agricultural lands, and the onset of an unusually harsh winter—led to the death by starvation of some 30,000 people. Detailed birth records collected during that so-called Dutch Hunger Winter have provided scientists with useful data for analyzing the long-term health effects of prenatal exposure to famine. Not only have researchers linked such exposure to a range of developmental and adult disorders, including low birth weight, diabetes, obesity, coronary heart disease, breast and other cancers, but at least one group has also associated exposure with the birth of smaller-than-normal grandchildren. The finding is remarkable because it suggests that a pregnant mother's diet can affect her health in such a way

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[1] Albert. A. Michelson, speech at the dedication of Ryerson Physics Lab, U. of Chicago 1894.

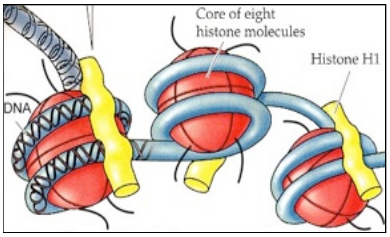
[2] http://www.eskimo.com/~billb/weird/end.html

[3] http://www.nature.com/scitable/topicpage/Genomic-Imprinting-and-Patterns-of-Disease-Inheritance-899

that not only her children but her grandchildren (and possibly great-grandchildren, etc.) inherit the same health problems.

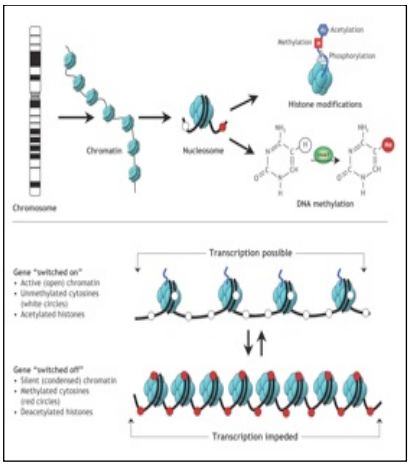
"In another study, unrelated to the Hunger Winter, researchers correlated grandparents' prepubertal access to food with diabetes and heart disease. In other words, you are what your grandmother ate. But, wait, wouldn't that imply what every good biologist knows is practically scientific heresy: the Lamarckian inheritance of acquired characteristics?"[1]

In this case, the epigenetic information involved chemical tagging of the histones, the protein 'spools' on which the foot-long DNA molecules are wrapped around to keep them manageable. To the right is a drawing of how histones and DNA combine:



Reversible and site-specific histone modifications occur at multiple sites through acetylation—replacing a hydroxyl with an acetyl group—of the histone proteins. It would seem—and this is currently an active area of research—that there is a connection between the epigenetic information written on the DNA and that written on the histones working in complementary directions: Methylation of DNA turns it off while acetylation of histones turns them on. It seems that methylated DNA on non-acylated histones is hard to unwrap—so its information cannot be easily accessed—while un-methylated DNA on acetylated histones is easy to unwrap and its information is more easily accessed.

The diagram to the right is a summary of what is currently known about the mechanism of epigenetic inheritance: This mechanism of storing information about the current state of the organism is now well-established; there are probably other mechanisms at work as well.



Most of the investigations into epigenetic mechanisms are currently focused on medicine and the state of disease, such as cancer, etc. There has not been much work on how this field impacts the mechanisms of evolution but it is clear that a new principle is involved.

Information about the current state of the organism is imprinted on the genetic heritage and can be accumulated over the ages as it is passed on down a lineage.

"The field of epigenetics has gained great momentum in recent years and is now a rapidly advancing field of biological and medical research. Epigenetic changes play a key role in normal development as well as in disease. The editor of this book has assembled top-quality scientists from diverse fields of epigenetics to produce a major new volume on current epigenetics research. In this book the molecular mechanisms and biological processes in which epigenetic modifications play a

[1] https://notes.utk.edu/Bio/greenberg.nsf/0/b360905554fdb7d985256ec5006a7755

primordial role are described in detail…. The final chapter describes the fascinating potential transfer of epigenetic information across generations."[1]

Epigenetics and Recombination

Recombination, or 'crossing over,' as it is otherwise called, occurs in the generation of the sex cells where two copies of a paternal chromosome and two copies of a maternal chromosome (i.e., 8 strands of DNA) entangle and crossover their genetic material.

> Chromosomal crossover (or crossing over) is an exchange of genetic material between homologous chromosomes. It is one of final phases of genetic recombination, which occurs during prophase-1 of meiosis in a process called synapsis. Synapsis begins before the synaptonemal complex develops, and is not completed until near the end of prophase-1. Crossover usually occurs when matching regions on matching chromosomes break and then reconnect to the other chromosome.[2]

It is this mixing of the genetic material that is at the heart of sexual reproduction and, since only sexual species evolve and spin off daughter species Sex can be considered to have a central role in evolution. In Darwinism, this process of breaking and reconnecting the DNA is considered random even though it is well-established that there are 'hot-spots' (where crossing over occurs with a high frequency) and 'cold spots' (where crossing over never occurs).

Evidence is accumulating that there is a link between 'short term' epigenetic information and recombination with its long-term consequences. This is from the report of a biology convention in 2006:

> "Carmen Sapienza (Temple University Medical School, Philadelphia, USA) reported that imprinted regions in humans are historical hotspots of recombination. Together with specific DNA sequences, epigenetic factors may have an important influence on the rate of meiotic recombination and the position of cross-overs. Using *in silico* and *in vitro* analyses, Sapienza's group have shown a relationship between increased rates of meiotic recombination and genomic imprinting. Imprinted regions showed more linkage disequilibrium, and had a significantly higher number of small haplotype blocks [passed down without recombination}, than the non-imprinted regions. Their findings suggest that several factors, including both specific DNA sequences and epigenetics, are involved in controlling meiotic recombination in humans."[3]

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[1] Jörg Tost. *Epigenetics* Caster Academic Press, Norfolk, UK, 2008 Review on Google Books.

[2] http://en.wikipedia.org/wiki/Chromosomal_crossover

[3] Advances in the genetics and epigenetics of gene regulation and human disease: A report on the Human Genome Organisation (HUGO) 11th Human Genome Meeting, Helsinki, Finland, 31 May-3 June 2006. http://genomebiology.com/2006/7/8/325

Other groups have also established connections between epigenetics and the rearrangement of the genome in recombination including the arabidopsis plant[1], in humans[2], in the centromeres that control the structure of the eukaryote cell[3], and in the recombination that underlies the antibody diversity in the immune system.[4]

Why sex?

One of the 'open questions' in modern biology is: "Why sex?" The overwhelming preponderance of sexual reproduction in multicellular organisms is a puzzle because asexual reproduction is so much more efficient at generating progeny.

It is a well-known fact that, while Darwin titled his epochal work, The Origin of Species, he did not actually propose any mechanism for the emergence of new species. The ideas he proposed, at best, dealt with the origin of races within a species, not new species themselves. To this day, there is no consensus as to how this happens other than a process of gradual divergence and gradual infertility between races.

This does accord with what is known, however, as illustrated by the human race. There has certainly been a lot of epigenetic learning and writing to genetic memory in the many tens of thousands of years since the first humans emerged in Africa. These are the human variants we call races.

> The first theory, known as the 'Out of Africa' model, is that Homo sapiens developed first in Africa and then spread around the world between 100 and 200,000 years ago, superseding all other hominid species. The implication of this argument is that all modern people are ultimately of African descent. The other theory, known as the 'Multi-regional' Model, is that Homo sapiens evolved simultaneously in different parts of the world… Although the debate is far from concluded, it is probably fair to say that the bulk of scientists support the 'Out of Africa' hypothesis and believe that all humans share a common origin.[5]

Examples of the innovations expressed in the emergence of the human races are the ability to digest milk through adulthood (a rarity in the stay-at-home Africans; common in Europeans) and the loss of UV-protecting-but-vitamin-D discouraging melanin in the races in sun-deprived northern latitudes. For all these epigenetic and genetic changes, however, the ability of Black Africans and White Europeans to interbreed is in no way diminished.[6] In fact, a quite-opposite phenomenon is firmly established in

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[1] Haibo Yin, Xia Zhang, Jun Liu, Youqun Wang, Junna He, Tao Yang, Xuhui Hong, Qing Yang, and Zhizhong Gong. Epigenetic regulation, somatic homologous recombination, and abscisic acid signaling are influenced by DNA polymerase epsilon mutation in arabidopsis. Plant, Cell, 21(2):386,Äì402, February 2009.

[2] HapMap methylation-associated SNPs, markers of germline DNA methylation, positively correlate with regional levels of human meiotic recombination Genome Research, Vol. 19, No. 4. (26 April 2009), pp. 581-589. by Martin I. Sigurdsson, Albert V. Smith, Hans T. Bjornsson, Jon J. Jonsson

[3] http://www.epidna.com/showabstract.php?pmid=18541703

[4] http://www.reeis.usda.gov/web/crisprojectpages/207316.html

[5] http://www.bbc.co.uk/worldservice/specials/1624_story_of_africa/page92.shtml

[6] Experimentation in this area has begun. For example, see "Hybrid Vigor and Transgenerational Epigenetic Effects on Early Mouse Embryo Phenotype" at: http://www.biolreprod.org/content/79/4/638.abstract

biology: that of hybrid vigor: “An increase in the performance of hybrids over that of purebreds, most noticeably in traits such as fertility and survivability.”[1]

In the theory presented here, the epigenetic-directed recombination of genetic material is the key mechanism of speciation and resultant reproductive isolation. Evidence that this might be correct is to be found in the rather odd sequence of events leading up to the formation of the haploid sex cells (with one set of chromosomes) from the diploid germ cells (with two sets of chromosomes). One obvious reason for this haploid-diploid alternation is to prevent a buildup of chromosome number that would happen if the sex cells were diploid—the children would have four sets, the grandchildren eight, the great-grandchildren sixteen, etc.

The obvious way to get two haploid cells from a diploid cell would be to have a regular cell division (mitosis) that skips the chromosome duplication step. This is not the case. The formation of the sex cells (meiosis) adds a seemingly unnecessary step that just adds to the workload. First, the two sets of chromosomes—the paternal set and the maternal set—are duplicated. The cell now has four sets of chromosomes! These all commingle into what is called the tetraplex or synaptic complex[2] —the stage when recombination and reorganization of the genetic material occurs. The four sets of chromosomes are now progressively reduced to one set by two rounds of cell division to create four haploid sex cells.

Current biology has no good rational for this complicated way of doing things as recombination is considered to be random chance-and-accident. In the perspective developed here, however, this abundance of chromosomes hints at some currently-uncharacterized mechanism for the directed reorganization of genetic material while also ensuring that the new daughter species can be ‘brought to term’ successfully by the mother species.

If epigenetic-directed recombination turns out to be at the heart of speciation, it would provide a simple answer as to why almost all species are sexual: only sexual species can evolve, only sexual species can give rise to new species and more sophisticated organisms. The adoption of the asexual mode of reproduction, while advantageous in the moment, is an evolutionary dead end.

> The evolution of traditional, female-only asexuality typically leads to a swift extinction. We know this because although such species frequently evolve, they don’t stay around for long. If you look at the tree of life, female-only asexual groups are all out on the twigs: there are no great asexual lineages equivalent to fish or birds. Instead, the asexual groups are a few species of snail here, a dandelion there.[3]

Without sex, the highest form of life would be the simple unicellular forms that predominated the first billion years of life on earth and there would have been no Cambrian Explosion of multicellular forms and certainly no humans. Unification Thought puts sexuality at the very center of human life (and the Fall). If this perspective has any validity, it would seem that Molecular Biology has sex as the dynamo of evolution.

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[1] http://www.alpacas.com/AlpacaLibrary/GlossaryGL.aspx

[2] http://www.nature.com/nrm/journal/v4/n11/glossary/nrm1241_glossary.html

[3] http://judson.blogs.nytimes.com/2008/09/23/evolving-the-single-daddy/

Short term and Long Term Memory

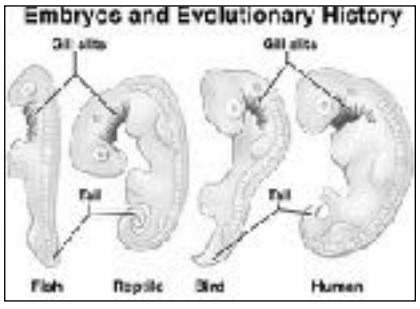
In the perspective we have developed, DNA is a long-term digital storage medium for analog memories. RNA, being more labile, is for short-to-medium storage. If this is so, then the DNA sequence of, say, the aged human brain, should be different from the sequence from aged cheek cells. If these were just mutational errors, these differences should be randomly scattered. If, however, they are a result of accumulated memories, they will be localized in distinct areas. This is akin to the paradox in the Modern Synthesis that states that 'mutations' are random events that are confined to 'hot spots,' while the conserved 'cold spots' show very little change. The changes are clearly not random, as the living system is controlling where they are occurring.

It has been said that the changes in the DNA sequence of modern humans are too great to have occurred if there were a single First Human pair ~100,000 years ago from which all humans are descended. In the Modern Synthesis, this would necessitate a mutation rate so great that it would be inimical to any continuity. For in the Modern Synthesis view, for every random change that is 'fit to survive,' there are many more that are not.

In the view developed here, these changes are not random, they are 'ancestral wisdom' accumulated down a lineage. Examples of such deep-time storage are particularly noticeable in the digital information for generating ancient proteins that have found a use in a variety of situations.

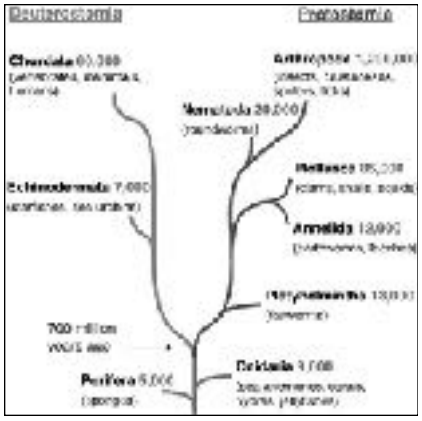
An example is cytochrome C, a large transmembrane protein complex found in ark bacteria, the mitochondria of all eukaryotes, and the chloroplasts of all plants. It is the last enzyme in the respiratory electron transport chain in membranes, and plays a vital role in photosynthesis and the role of oxygen in generating ATP. While it is primarily life-supporting, when a cell in multicellular organism receives an apoptotic stimulus (to commit suicide), cytochrome C is released from the mitochondria into the body of the cell and triggers programmed cell death. Playing so many crucial roles, the digital information has hardly changed since its form was captured from the Logos, billions of years, and the digital information passed down the lineage of life to all bacteria, fungi, plants and animals. The divergence, as illustrated, is only 50% since our lineage and that of pond scum diverged 3 billion years ago.

The Unification Thought perspective on Evolution, where aspects of the Logos are discovered and passed on down a lineage, is just like the Modern Synthesis of Darwinism and genetics except that random chance and accident variation is replaced by learning about the structure of the Logos and lineal transmission of this wisdom.



A consequence of this lineal descent, is that once an effective way of doing something becomes well-established, it is difficult if not impossible to do otherwise. It is this conservatism that gives rise to the epigram: "Ontogeny recapitulates phylogeny." This is a catchy phrase coined by Ernst Haeckel, a 19th century German biologist and philosopher, to mean that the development of an organism (ontogeny) expresses all the intermediate forms of its ancestors throughout

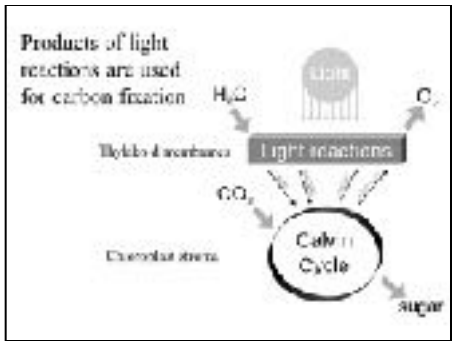
evolution (phylogeny). [A friend of mine was once excoriated for telling his newly-pregnant wife that the baby was only at a worm level, so not to worry!]



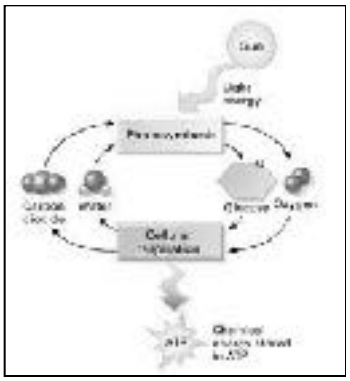
An intriguing example of this continuity down a lineage is the development of the mouth and anus. The very basic sequence that all multicellular animals follow is. a.Hollow ball of cells formed. b. Hole-1 established at one end for import and export of nourishment c. Hole-2 established for separate export of waste. All animal embryos get this far.

Then something happened about 550 million years ago when evolution had reached the Logos-level of the worm. A lineage discovered that Hole-2, being less ancient, had greater possibilities for exploration that Hole-1 did. The wormed turned, so to speak, and Hole-2 became the mouth and Hole-1 became the anus. This initiated the Deuterostome lineage, which eventually led to the invertebrates, the fish, reptiles, mammals and humans. The lineages that did not make the turnabout, the Protostomes, led to the earthworms and insects.

The most important thing learnt from the Logos, by far, was how to capture the energy in the abundant sunshine, and use it to strip hydrogen from water—liberating oxygen as a byproduct—and unite carbon dioxide with this hydrogen to generate carbohydrates.



The light energy is used to generate ATP and NADPH (activated hydrogen) via a cascade of cytochromes. This occurs in the light. In the dark, an enzyme called Rubisco unites carbon dioxide with ribulose, a 5-C sugar, which is driven by the ATP and NADPH in the Calvin cycle to generate glucose and regenerate the ribulose to repeat the cycle[1].



Almost all life on Earth depends on this photosynthetic generation of glucose and, not surprisingly, the Rubisco protein is by far the most prevalent protein on Earth. This intricate and sophisticated process was learnt from the Logos ~3 billion years ago, and has been passed down essentially unchanged to this day. It took many scientists many generations to unravel this essential process in all its complexity[2], but it was always there in the structure of the Logos. Once oxygen became plentiful, animals learnt from the Logos how to reverse the process, turning sugar and oxygen back to CO_2 and water and liberating the energy captured from the sun to power the animal kingdom.

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[1] https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-calvin-cycle-reactions/a/calvin-cycle

[2] Eating the Sun: How plants power the planet. Oliver Morton. Harper-Collins Publishers. 2007.

Extraterrestrial Life

In contemporary science. the concept of natural law determining what happens fades out about the level of biochemistry. While mo scientist considers the structure of water to be chance-and-accident, this belief fade out in the higher realms of biochemistry; while the inorganic synthesis of adenine is controlled by natural law[1], the combination of L-amino acids and D-ribose in the protein-nucleic acid relationship is considered a random occurrence[2].

In the debate between atheistic science and theistic science, it is becoming clear that physics is more and more tending to the theistic point of view: that God designed natural law with humans in mind. This is based on what I call the Agatha Christie Principle. In a Poirot novel, she pronounce the famous phrase (used and abused everywhere): "One coincidence is just a coincidence, two coincidences are a clue, three coincidences are a proof." Just one aspect of modern physics, the synthesis of carbon from helium, involves three coincidences, and yet another coincidence to explain why all the carbon does not convert to oxygen.[3] In an egregious violation of Occam's Razor—a principle attributed to the 14th century logician and Franciscan friar William of Ockham that "Entities should not be multiplied unnecessarily." —atheistic theorists have postulated that ours is just one universe, and the only one we can experience—of 10^{500} universes where everything is different and ours is the one that is "just right" for carbon-based life.

In the atheistic view, life is just a happenstance and could arise in many ways. My favorite author. Issac Asimov, was fond of speculating about the varieties of life, such as H_2S instead of H_2O, where plants excreted solid sulphur rather than gaseous oxygen.[4]

This brings us to different predictions by science and religion (not a usual occurrence) where one is proved right and the other proved wrong. This will occur when we travel to extrasolar planets—as discussed in the final chapter—and examine extrasolar living organisms.

The chance-and-accident aspect of contemporary science predicts that a huge and various kinds of life will be uncovered, As one of the 20th century preeminent evolutionist, Steven J, Gould. predicted: replaying the history of life would have been dramatically different from the actually observed course of events because evolution is essentially a stochastic phenomenon whereby trajectories that start infinitely close to each other soon diverge because the divergence is exponential.[5] This view predicts that life on other planets wold be radically different, even poisonous, to our kind of life.

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[1] http://www.pnas.org/content/112/3/643.full.pdf

[2] https://www.reddit.com/r/askscience/comments/2kolbb/why_only_l_amino_acids_and_d_sugars_are_involved/

[3] https://en.wikipedia.org/wiki/Triple-alpha_process

[4] https://en.wikipedia.org/wiki/Hypothetical_types_of_biochemistry

[5] would have been dramatically different from the actually observed course of events because evolution is essentially a stochastic phenomenon whereby trajectories that start infinitely close to each other soon diverge because the divergence is exponential.

The UT view is quite different. The Logos as expressed over time would ensure that life on the planets would be similar, even nutritious, to our kind of life. Note that in this view an elephant and a yeast cell are similar in fundamental ways:

1. Their cells all use L-amino acids and D-sugars
2. Their cells activate molecules with ATP
3. Their cells are compartmentalized by phospholipid bi-membranes
4. Digital information is stored in DNA, manipulated by RNA, and translated into analog proteins

For this reason, we can speculate that the first expedition to a life-bearing planet will, perhaps, provide a proof of a Logos-based universe instead of a chance-and-accident universe.

It should be noted that extraterrestrial life does not imply intelligent life, as is being looked for by SETI and others. While bacteria-like organisms emerged (geologically) soon after the Earth cooled from its molten formation 4.5 billion years ago, they ruled the Earth for the next 3 billion, and is was the cyanobacteria who created the oxygen atmosphere. So the most probable situation is bacterial life and an oxygen atmosphere, just right for colonizing.

To my mind, the best overview of the stages by which living systems slowly learnt all about the Logos and burgeoned to fill the earth is the book, *Vital Dust: Life as a Cosmic Imperative* by Nobel Laureate, Prof. Christian de Duve[1]. He covers the whole history of life on Earth, from the establishment of protometabolism —the set of chemical reactions that first put life on track—to the emergence of the human mind.

While Dr Duve is careful to adhere to the contemporary dogma that it is random changes to DNA that generate variation for natural selection to filter, he is clearly unhappy with such an unprepossessing concept. He does, however, recognize that Natural Law is not just simple physics. As he states in his Preface:

"While not denying the role of contingency in evolution, I point out that chance operates within constraints—physical, chemical, biological, environmental—that limit free play. This notion of constrained contingency runs as a leitmotiv throughout my reconstruction of the history of life on Earth."[2]

He ascended to the spiritual realm before the epigenetic revolution got going, introducing the concept of *writing* digital information to genetics, so did not get the opportunity to include a lineage learning in his opus. But with this caveat, the book is highly recommended.

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[1] Christian de Duve, Vital Dust, Basic Books, New York 1995.

[2] ibid p.xvi.

THE LOGOS: ANALOG FORM AND DIGITAL INFORMATION

The efforts of dozens of scientists over the last few centuries have proved this simple, undisputed fact: All entities in the physical realm are composed of fundamental 'matter quanta'—e.g. electrons—and 'force quanta'—e.g. photons.

Quantum physics has has shown that all these elementary quanta have the same basic character:

1. They have an internal wave-like aspect that is strictly determined by natural law.

2. This internal aspect determines the probability of how the particle-like external aspect will move and interact

3. Matter quanta interact by coupling with force quanta from their external structure

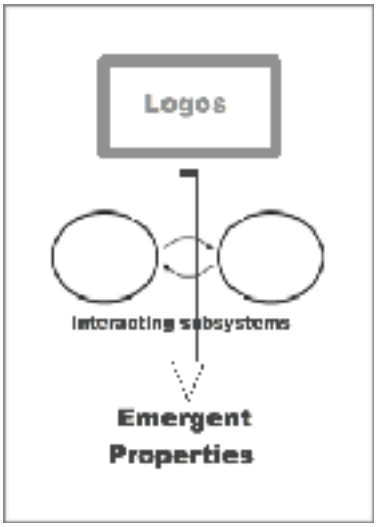
4. Interaction alters the internal aspect.

This can be summarized in the aphorism: The internal determines the history of the external; the external interactions determine the internal development.

The internal determines the external probability; external interaction determines how the internal will alter.

Emergent Properties

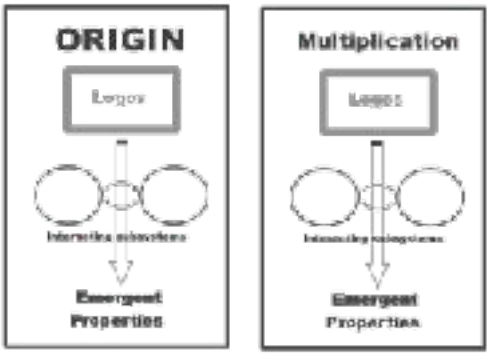
A well-known fact is that, on occasion, when two or more simple entities interact together they create a more sophisticated entity with properties not possessed by any of the simple entities. These new properties are called *emergent properties.* Some examples are:



1. Neither an electron nor a proton have the property called *chemical valence;* united as a hydrogen atom, this higher system does.

2. Neither sodium atoms or chlorine atoms possess properties beneficial to life, in fact they are both inimical to life. Yet when they interact as salt they have properties that are essential to all living systems.

The listing of such emergent properties is endless. Where do these emergent come from? This is a question that is not dealt with in the philosophy of current science. In Unification Science, however, the answer is clear: these emergent properties are derived from the Logos, an abstract entity created by God that exists in the same realm as mathematics does. It contains not only

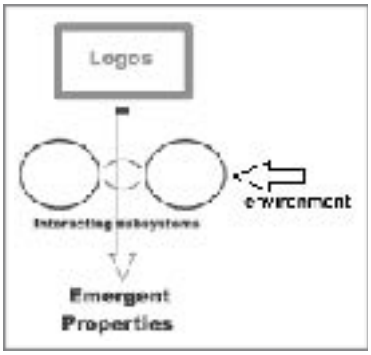


the natural laws now known to science, but also the properties that emerge when the laws are expressed.

In a general sense, when potential subsystems interact together as a tiger system, a new set of properties are inherited, so to speak, from the Logos. This applies from the simplest atomic systems to the most sophisticated living systems. The great difference between living and non-living systems is to be found in the emergence of the first instance of a system—the origin—and the subsequent emergence of the second, third, fourth etc.—the multiplication of the system.

Inanimate systems

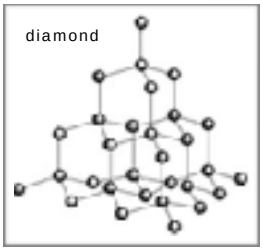
In the simplest of systems, the origin and multiplication of a system is identical. The subsystems interact, the system is formed and the properties emerge.

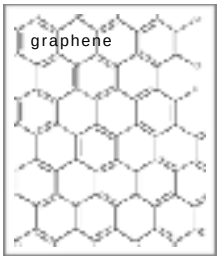


For example, after the Big Bang emergence of the universe, the temperature was far too hot for atoms to condense and all—ignoring the helium—was a plasma of free electrons and protons. It took about 300,000 years for the universe to cool to where electrons and protons could interact and remain together as a hydrogen atom. Logically, somewhere in the universe there must have been the first stable hydrogen atom and the first expression of the property of chemical valence inherited from the Logos. This moment marked the origin of hydrogen. Microseconds later billions of hydrogen atom emerged in the exact same way and the multiplication of hydrogen systems commenced.

In more sophisticated systems, the environment plays an even greater role in the interaction of subsystems thereby influencing the origin and multiplication of systems.

A simple example is the interaction of carbon atoms. When the environmental temperature and pressure are high, the atoms interact in three dimensions creating a macromolecular diamond crystal. When the temperature and pressure are low, the atoms interact in two dimensions creating a macromolecular sheet of graphene which, stacked in layers, is graphite.





We can add this environmental factor contributing to the interacting subsystems and the resultant emergent properties.

While in inanimate systems the origin and multiplication processes are the same, this is not the case in living systems, where the origin process and the multiplication process are different. Before we discuss this, however, we need to consider two related concepts: analog form and digital information.

emergent	diamond	graphite
light conduction	transparent	black
electric conduction	insulator	good conductor
hardness	very hard	very soft lubricant
heat conduction	very high all directions	high in graphene plane low across stacked planes

Analog and Digital

The basic nature of *analog* is smooth continuity while that of *digital* is discrete separation. In mathematics, a line is continuous and analog, while the digital integers are separated by unit gaps. A small set of simple analog forms can be used to store and recreate digital information about sophisticated analog forms.

Historically, our experience of the world is mainly analog; our thoughts, sights, sounds, smells, etc., all are smoothly continuous analog forms. Analog form is the way things are, while digital information about analog form has to be translated.

The earliest example of digital information used to capture and disseminate analog form is the invention of writing. A small set of analog symbols—the alphabet— is used to encode analog thoughts. While in earlier times this skill was confined to the ruling class, nowadays learning to read and write is considered essential for everyone.

Learning to translate is laborious, starting with recognizing letters as simple phonemes, small sets of letters as syllables, small sets of syllables as words. Eventually, speed readers can recognize the analog form of entire sets of words. I have no problem reading this example as: *Intelligence is the ability to adapt to change.* While useful, this skill makes proofreading an article such as this almost impossible so please excuse any typos herein.

It was only relatively recently that such encoding could be accomplished by using just two symbols, the smallest possible set. Such *binary* code underlies all the wonders of computers, smart phones, the internet, email, Google, Facebook, Amazon, etc.

The analog forms used to code such binary wonders come widely different. On paper, they are 0/1; on paper tape as Hole/NoHole; in silicon circuits as On /Off; in truth tables as True/False; in modems as High/Low tone; in memory chips as +/– charge; in magnetic stores as N/S magnetic poles; on CD, DVD and BlueRay as Pit/Land; in FM radio as High/Low frequency, etc.

For example, while watching a video on YouTube, the digital information switches through a variety of analog forms on its journey from server farm to internet to WiFi to CPU before being translated into the analog forms of sound and picture for your delectation.

Digital Manipulation

All the wonders of the digital age are founded upon a few simple mathematical ideas. In theory, all the different analog ways of coding are stripped away leaving only the mathematical digits of zero and one. Strings of ones and zeros are manipulated by a Central Processing Unit (CPU) that performs simple mathematical operations—billions of them each second—to create all the marvels we are now accustomed to.

NOT

Input	Output
0	1
1	0

XNOR

Inputs		Output
0	**0**	1
1	**0**	0
0	**1**	0
1	**1**	1

Etched in silicon, these *logic gates* take an input—one or more—and generates a single

output. By far the simplest gate is called NOT with a single input. If the input is 1 the output is 0; if it is 0, the output is 1. The logic of gates is expressed as a table, as illustrated.

Almost as simple are gates that take two inputs and generate a single output. A most significant one is the NAND gate. It is significant because, confounding all common sense, the NAND gate is universal and it is all you need to build a computer. That is theory, but you might need dozens of them concatenated together to perform a needed manipulation.

To save on silicon, many other 2-input gates have been designed such as: AND, OR, NOR, XNOR, XOR, etc. The XNOR gate, for example, outputs a 1 when the inputs are identical and a 0 when they are not.

NAND		
Inputs		Output
0	0	1
1	0	1
0	1	1
1	1	0

XOR		
Inputs		Output
0	0	0
1	0	1
0	1	1
1	1	0

The XOR does the opposite, it outputs 1 when the inputs are different and 0 when they are the same.

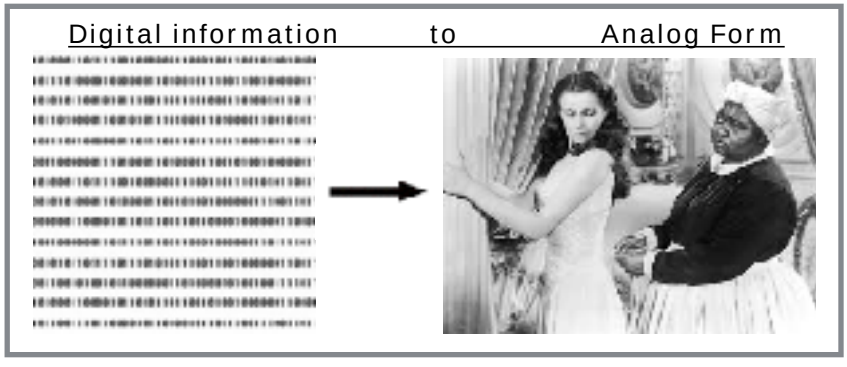
Translation

In computers, digital information can either be instructions or data, subject or object. In the earliest days of wordprocessing on PCs, it was mainly data with a sprinkling of simple commands. This was the advent of ASCII code when computers were able to manipulate eight bits at the same time, the byte.

The bits in the bytes range from 00000000 to 11111111, or in decimal form from 0 to 255. The first 128 bytes—0 to 127— are more than sufficient to code for the data for 52 upper and lower case alphabet, aA to zZ, plus the 10 digits 0-9, plus the common punctuation marks such as !@#$ %^&*()_+;:’”?<> etc.—all the data generated by clicking on a keyboard. A few codes, however, are more like commands such as #2 “start of text”, #3 “end of text”, #8 “back space”, #13 “carriage return” etc. The printable character data start at #32 “space” and ending with #126 “~” while #127 is the “backspace” command. The second 128 byes encode rarely used entities ending with #255 “y with diaeresis”.

In the earliest computers that could only manipulate 1 byte at a time, almost all stored digital information was ASCII code. If you typed a “q’ on the keyboard, the CPU looked in the ASCII table, four the ‘q’ and output it too the screen. The ASCII table mimicked the typewriter, the font was monospaced Courier.

Once computers advanced to being able to manipulate 2 or more bytes at a time, the ASCII data byte could be associated with style data byte. Nowadays when 64-bit computers can manipulate 8 bytes at a time, the ASCII data can be associated with a myriad of fonts, sizes and line and fill colors.



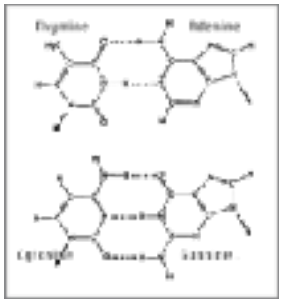
Saving a file as “plain text” just strips away all the style bytes leaving leaving only the ASCII bytes.

The ASCII lookup table in modern computers does not return a defined shape, it returns a small program of *Bezier curves,* a set of control and end points that determine the length and curvature of each segment of the final form—just a few for a simple ‘l’, many for a more complex ‘R’. The style data is used by the Bezier program to generate the myriad of type forms available now available to the graphic designer.

Living Systems

We can now apply these basic principles of digital information in the computer realm to the digital information used by living systems. The first lesson we can take form computers is to strip away the analog form that carries the digital information and replace it with simple mathematical symbols.

In computers there are two analog forms represented by the binary bits 0 and 1.



In DNA, there are four analog forms that come in complementary pairs, guanosine and cytosine, adenine and thymine (G/C and A/T.) In RNA, they are slightly different, G/C and A/U. These two pairs can be represented by the digits 0/3 and 1/2, or in binary code ‘bibits’ [bye bits] as 00/11 and 01/10.

The bases are linked to a ribose-phosphate backbone which has a free phosphate at one end and a free hydroxyl at the other. Almost all nucleic acid processing starts at the phosphate end and finishes at the hydroxyl end.

There are no silicon chips in cells that manipulate the analog form of digital information. Instead, predating silicon by eons, are the interactions of DNA, RNA and proteins.

As the information is encoded in bibits, we have two directions to consider: bases connected in a chain—the vertical direction ‘v’—and between chains of bases—the horizontal direction ‘h’.

Information stored on a double-stranded DNA helix is duplicated by complementing each strand of the parent DNA , resulting in two identical daughter helixes. The information on one strand of DNA is transcribed by assembling a complementary RNA strand. The information on one type of messenger RNA (mRNA) is translated into a chain of amino acids by complementing the mRNA with tRNA. In all these situations, the assembly of the complementary chain is equivalent to a horizontal NOT logic, ‘hNOT’.

There are enzymes that scan double helix for mismatches that are deleted and replaced. This is logically similar to the XOR that outputs a 1 when the bits of a bibit are complementary and a zero when they are not.

hNOT	
Input	**Output**
00	11
11	00
01	10
10	01

hXOR		
Inputs		**Output**
0	**0**	0
1	**0**	1
0	**1**	1
1	**1**	0

vXNOR		
Inputs		**Output**
0	**0**	1
1	**0**	0
0	**1**	0
1	**1**	1

A helix that is correctly paired has an output of all 1s while any mismatch results in a 0 output. This zero is a trigger for a set of enzymes to excise the base and replace it with a correct one. This is equivalent to a horizontal XOR logic, hXOR.

There are three bonds between a G-C pair and two between a A-T/U pair. A triplet that is all Gs and Cs has 9 bonds while those with all As and Ts has 6 bonds. This difference in bonding strength has consequences, a topic of current investigation. This involves the bibits along a strand and is is a vertical logic similar to the XNOR logic. A triplet all Gs and Cs will output 111, all As and Ts will output 000, while mixed ones intermediate values. There are also many logical manipulations we need not discuss further. Two examples:

Adenine can be chemically modified to inosine which can pair with cytosine with two H-bonds. The C then complements with G. This is a 01 to 00 change, a vNOT logic on half a bibit.

In certain circumstances a G will pair with a U, a *wobble* pairing that is a logical vXOR where the distortion, output 0, can acts as a signal.

There are probably dozens more as the interaction of the multitude of RNA types are just now being explored.

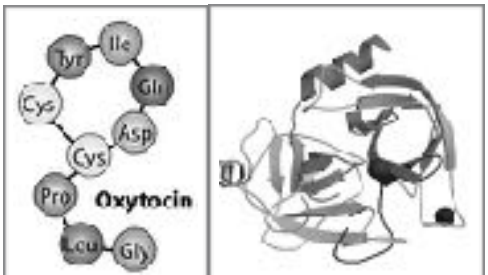
The Central Processing Unit

DNA is almost the same as RNA. The only difference is that DNA does not enjoy the company of water so much—each ribose sugar along the backbone has an hydroxyl (–OH) replaced with a hydrogen (hence the *deoxy* appellation), and a dab of oil—a methyl group—added to each uracil in the chain (which is what makes it a thymine). While DNA coils up to exclude water, RNA does not.

In the simple bacteria-like *prokaryotes*—who characteristically lack a nucleus sequestering the DNA from the rest of metabolism—the role of RNA is mainly the transcribing and translating the digital information from DNA into protein.

In the more sophisticated and complex eukaryotes—with a sequestered nucleus—there is a need for a lot more control and command to coordinate and integrate the interactions of the multiple organelles. This is accomplished by a ‘cloud’ of RNA molecules that—along with proteins—control the output of the nucleus. Along with the mRNA, tRNA and rRNA active in prokaryotes, there are dozens of ‘non-traditional’ RNAs active in the eukaryote nucleus with a plethora of different activities. This is currently a burgeoning subject and seemingly a new class of RNA is announced every month or so. The Wikipedia “List of RNAs” page, which is a good place to start exploring this subject, lists 10 different RNAs involved in post-transcriptional modification or DNA replication, 12 types of regulatory RNAs, and more.

The activity of this cloud of RNA in the nucleus is akin to the CPU of a modern computer with is millions of silicon transistor-gates, manipulating digital information from storage before outputting it for translation.



Proteins and Analog Form

It is the ability to communicate with language that is central to the human experience. Speech, however is ephemeral, and while memorizing epic poems and sagas were a way to pass on analog information, it was inefficient. It was the invention of writing that allowed the efficient passing on of knowledge in digital form.

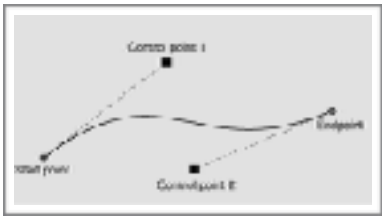
Living systems have an analog structure and function, and almost all of this is performed by proteins. In plants, it is proteins that assemble the structures that capture light energy to turn water and carbon dioxide into the plant structure and food for animals. In animals, it is protein enzymes that break down food into the universal monomers of life—sugars, amino acids, etc,—and build them back into the polymers of the individual. It is proteins that are muscles, move muscles, shape cells, tissues, organs, etc. It is proteins who generate the structure and underly the functioning of the brain. Almost all the analog aspect of life is generated by proteins working in concert with each other.

Attesting to the unity of life, all varieties from bacteria to human, use the same 20 amino acids to construct their proteins. The extreme differences between the millions of different proteins found in the biosphere is not found in the type amino acids, rather it is to be found in the order that they are linked together. This is chain of amino acids—with a free amino and one end and a free acid at the other—is called the primary structure of a protein. For some proteins this is it, while for others there is further processing such as the cross linking with disulphide bonds between one or more chains, addition of sugars or other moieties, the assistance of chaperons, etc. For all, however, the final step is a complex folding into the active form of the protein, a form that determines the analog activity of that protein.

```
This is 12pt
Courier, no
other font is
available.
```

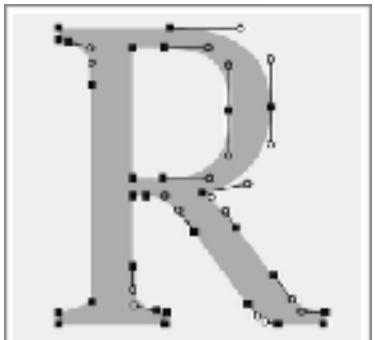
In modern computers, the ASCII code is extended by adding information about a sequence of Bezier points with attached characteristics such as length, curvature, color, etc. This is analogous to the sequence of amino acids that each have a set of inherent characteristics such as alpha helix or beta sheet tendency, hydrophobic or hydrophilic nature, aromatic resonance, H-bonding ability. Just as the sequence of Bezier points characteristics combine to define the final analog form of a letter, the sequence of amino acid characteristics combine to define the final form of the active protein, and hence its activity it contributes to a cell's metabolism.

ASCII
Data plus
commands



Many proteins are created in an one state. The binding of entity—a substrate of regulatory signal such as calcium ions or cyclic AMP—adds a new set of factors and the form of the protein radically changes the form into a new form that has a new set of analog capabilities. Such *allosteric* change of form is commonplace, such as the binding of a substrate to an enzyme, the enzyme flips to another analog form which transforms the substrate into a product which is released and the protein regains its original form.

This sensitivity of form and function to the set of Bezier-like amino acids is why many genetic diseases involve just one inappropriate amino



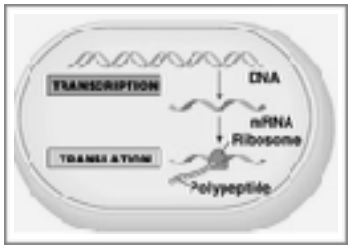
acid in the chain. Sickle cell anemia, for example, is caused by a single wrong amino acid in the the 146 amino acids in the primary structure of the beta subunit of the hemoglobin molecule.

All the myriad of activities of all such proteins depend on their analog form, and this is a direct consequence of the primary sequence of the amino acid chain. This crucial sequence is determined by digital information.

Digital to Analog

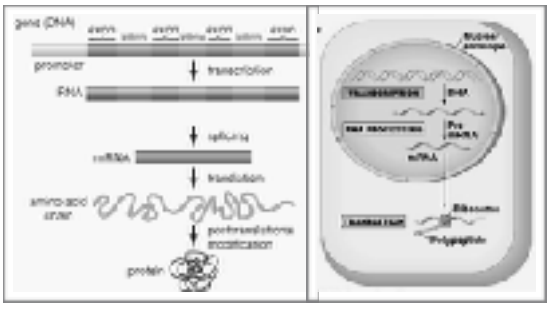
Akin to the 8-bit ASCII byte which codes for the 256 letters etc. input from a keyboard, living systems use a 3-bibit Triplet Code which codes for the universal 20 'natural' amino acids used by all living systems to generate proteins. Just like ASCII which codes a few simple commands, the triplet code also has codons that instruct 'start' and 'stop' assembling a protein form amino acids.

In all forms of life, the process of generating the primary sequence of a protein is basically the same. At one end of a *transfer RNA* (tRNA) is a codon (technically an *anticodon)* while at the other is attached one of the amino acids. The enzymes that match codon to amino acid are at the core of translation.



A stretch of DNA (anticodons) is complemented into a *messenger RNA* (codons) molecule. One end of this mRNA passes into a ribosome—a complex of rRNA and protein—where the first codon is complemented by the anticodon on a loaded tRNA. Codon by codon the mRNA is pulled through the ribosome and the sequence of codons is translated into the sequence of amino acids, the primary structure of a protein.

The simplest and earliest forms of life, the *prokaryote* bacteria, just like the earliest computers, have almost all of their digital information stored on DNA as triplet code that is translated into protein. So intimate is this process that many ribosomes attach to the mRNA before it is completed so that transcription, translation and protein synthesis all occur simultaneously. Such rapid synthesis of protein is one of the reason bacteria can grow so rapidly and multiply in 20 minutes or so.



The DNA of later, and more sophisticated living systems, the *eukaryotes*, store triplet code information embedded with instructions. Just like the "make plain text" process of sophisticated computers, the triplet code information—the exons—is stripped away from the non-translated *introns*, and the exons spliced together as an mRNA to be exported to the ribosomes outside the nucleus.

The intron RNA joins the RNA cloud in the nucleus as input to the CPU that influences the output of the nucleus. In the eukaryote DNA, only about 10% is exon that will be translated by the ASCII code into protein. The rest is sophisticated information. Similarly, this document with all the formatting,

diagrams and fonts etc. takes up 10,200,000 KB of space. When saved as Plain Text, however, just ASCII and nothing else, it is only takes up a mere 21 KB.

Unlike simple bacteria store digital information about protein sequence, and little else. Sophisticated entries such as yeast, plants and animals, store a lot of information about proteins along with a great deal of other information.

Writing and Reading

In the realm of computers, there are two basic aspects to digital information, first come *Writing* it to storage, then comes *Reading* it from storage. Typing on my keyboard, the letters are displayed on screen. I can backspace or overtype until my thought is well-expressed, then I can select it, alter the type face, the size, the color; I can inset a graphic or a hyperlink. Every now and then, I choose the Save command and the document is saved from short-term memory into long-term memory.

In this stored form, the digital information can be endlessly duplicated and shipped all over the world on disks or over the internet. Writing comes first; Reading comes second.

The Modern Synthesis of molecular genetics attempts to explain how life evolved over 4 billion years from simple bacteria, to yeast, to plants, to animals, to humans. While computer theory and genetic theory have been in essential agreement so far in the discussion, at this point they diverge completely.

Almost until the start of the 3rd millennium, this theory was all about the Reading of digital information. Theorists proclaimed “the central dogma of molecular biology” to be that the flow of information was a one-way path from digital genotype to analog phenotype: from DNA to RNA to protein to organism. There was not an intimation of how the digital information got Written into the DNA. Lacking a Write mechanism, the modern synthesis rephrased Darwin’s concept of *random variation* into genetic concepts as *random variation of DNA.* Natural selection allows useful changes to continue down the generation, harmful changes are jettisoned ASAP.

This is a truly bizarre concept when viewed in the light of computer evolution. I personally experienced this living through their rapid evolution from the 1983 *TRS-80 Model 100* (32 kB memory, 2.46 MHz CPU, B&W screen, cassette tape storage) to the computer I am writing on, 2015 M*acAir* (8 GB memory, 1.6 GHz CPU, 32-bit color screen, 128 GB solid-state storage). I hitched myself to the Mac in 1986 with the Mac XL, then a MacPlus, and upgrading every 3 or 4 years until my current charmer. For most of this time, the personal computer realm had two principalities: Apple and Microsoft. In my culture of Apple users, we were acidly scornful of MS Windows attempts to emulate the grace and stability of the Mac Operating System. It’s problems and crashes were legendary, prompting the sneer: They believe in random variation so they indiscriminately daily alter the code for Windows to see if they come up with any improvements.

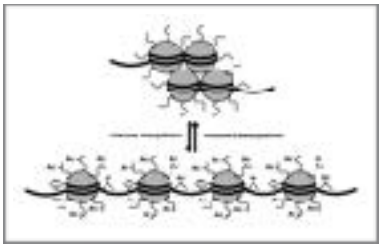
Anyone who has ever written computer code, even in BASIC, knows how much effort it takes, and how easily things go awry. Yet for decades this was the central dogma of evolutionary thought.

The first crack in this dogma was revealed in the study of the RNA viruses. The first thing these pests do on entering a victim is to use its protein-making machinery to translate a portion of the viral into a protein called Reverse Transcriptase. This disobeys the dogma and copies its RNA into DNA. This DNA then suborns the cell metabolism and directs it into a virus factory. [This suggests that a mechanism for a single RNA to alter the history of the cell already exits to be exploited by the virus. This suggests that passing digital information between cells might have a role in development from zygote to individual to complement the partially-understood analog influence such as molecular gradients.]

That much remains to be uncovered in this are is the fact that in the 90% of the human genome never seems to be translated into protein—so called *junk* DNA—are thousands of sequences that are remarkably similar to the sequence that generates Reverse Transcriptase activity. Current techniques are too coarse to notice DNA that might only be called on once a day, a month, a year, or even a lifetime, so to declare all these thousands of sequences ‘inert’ is premature.

Epigenetics

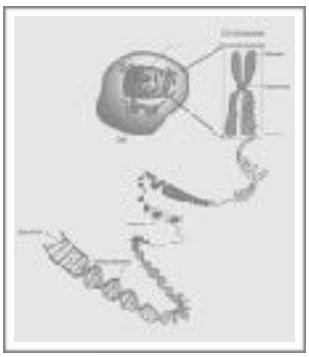
While the action and ubiquity of Reverse Transcriptase was a minor challenge to the random variation concept of the Modern Synthesis, in the last few decades a major chasm has developed, starting with a most unexpected finding. During the Second World War, extremely stressful situation were imposed on the civilian populations in the Dutch famine of 1944 and the siege of Leningrad. Grandchildren of survivors were found to have effects such as reduced life expectancy and greater susceptibility to diseases such a heart problems and diabetes. This suggested that some influence of the environment was being genetically passed down the generations, something that was anathema to the Central Dogma.



With such simple beginnings began the currently-burgeoning field of Epigenetics.

Genetics is the study of long-term, and deep-time storage of relatively unchanging digital information some parts of human enzymes are identical to bacterial enzymes whose lineages separated billions of years ago. In contrast, epigenetics is the study of short-term storage of digital information changing over generations. It received the *epi-* moniker because it is not written *into* the genetic DNA, but *onto* the DNA and its protein support structure. If DNA genetics is akin to the hard drive of a computer, epigenetic DNA is akin to its short-term working memory.

DNA is fine threads of an extraordinarily-long molecule and, like any long thin threads, need to be carefully managed so that gordian tangles are avoided. This is the role of histone proteins in all eukaryote cells.



Histones are highly basic proteins—meaning they’ve got some positive charge hanging off them. It also means they’re attracted to negative charge--like the negative charge clustered around the sugar phosphate backbone of DNA which DNA stably wraps itself around histones, like thread on a spool. The

DNA helix wraps twice around a spool of one set of histones, and this spool aggregates around another set of histones, and the compaction can occur until the entire length of DNA is compacted into a short chromosome visible under a microscope. This is analogous to taking miles of cotton thread on spools and packing dozens into a small box.

There are many different methods used to imprint DNA, some stimulate its transcription into RNA while others inhibit it. DNA methylation, the first recognized and most well-characterized epigenetic modification, is linked to transcriptional silencing, and is important for normal gene regulation and development of the organism, as well the abnormal starting of cancers. In mammalian cells, DNA methylation occurs at the 5' position of the cytosine ring within CpG dinucleotides. Distinctive distribution patterns of CpG methylation are believed critical for the control of gene silencing and chromosomal stability. For example, hypermethylation in repetitive sequences combined with histone modifications can result in the condensation of chromatin DNA into inaccessible heterochromatin states.

In contrast to this 'turning off' process, acetylation removes positive charges and reduces the affinity between histones and DNA, thereby opening the condensed chromatin structure to allow transcriptional machines easier access. Histones are also modified by addition or removal of methyl groups, phosphate, the polypeptide ubiquitin, etc. which can stimulate or inhibit formation of RNA.

The addition of methyl and acetyl groups is performed by enzymes that are recruited into action by RNA. Both inhibition and stimulation are controlled by non-traditional RNAs from the RNA Cloud recognizing stretches of DNA and initiating some modification. These epigenetic RNAs play a role in heterochromatin formation, histone modification, DNA methylation targeting, and gene silencing.

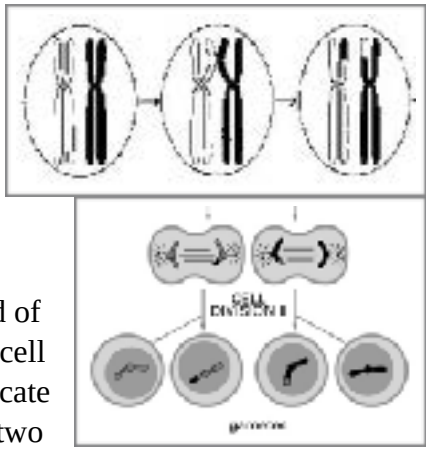
Histone modifications are critical for regulating chromatin structure and function, which can in turn affect many DNA-related processes, such as transcription, recombination, DNA repair and replication, and chromosomal organization. All of which are controlled by the RNA Cloud, the CPU of digital information. The most extreme example is when Xist RNA coats one of a female's two X chromosomes resulting in the complete condensation of the chromosome into the utterly inactive Barr body, resulting in a single active X chromosome as in the male. By far the most significant finding is that epigenetics is linked to recombination, the process that is central to the creation of the next generation. This is when short-term memory is written into long-term memory; when epigenetic information becomes genetic information; when the Central Dogma of the Modern Synthesis is refuted.[1]

Recombination

In diploid eukaryotes with two sets of chromosomes, the duplication of cells is by *mitosis.* The DNA is duplicated and condensed into two chromosomes joined at a spot called the centromere. The nucleus wall (usually) disappears, a *spindle* of micro fibers pulls the duplicated sets of chromosomes apart, two nuclei walls are assembled around them and a construction separates the cell into two daughter cells each with an identical nucleus. For unicellular eukaryotes, this is also also asexual reproduction.

[1] For more detail and references see: www.whatisepigenetics.com/non-coding-rna

In multicellular, sexual eukaryotes—all of the visible living systems—reproduction is much more complicated as haploid sex cells with only one set of chromosomes have to be brought together so that they can fuse into a diploid zygote which then goes through multiple rounds of cell division by mitosis to generate the organism. At the foundations is cell division by *meiosis* to generate the haploid sex cells.



Meiosis is similar to two rounds of mitosis but with only one round of DNA replication. The first round is almost identical: the diploid parent cell with its paternal and maternal sets of chromosomes match up and duplicate its DNA to form form a tetraplex of four chromosomes, two from dad, two from mom. This is one difference between mitosis—where the chromosomes do not match up into a tetraplex which is the site of active *recombination.* Under the guide of the RNA Cloud, as already noted, enzymes cut and reconnect together members of the tetraplex, usually just mixing up bits of the paternal and maternal chromosomes. This can happen many times on the chromosomes, scrambling the maternal and paternal chromosomes together.[1] After this period of recombination, the double sets are pulled apart just as in mitosis. Creating four gamete cells which develop into four spermatozoa (male) or one egg and three helper *polar* cells.

Speciation

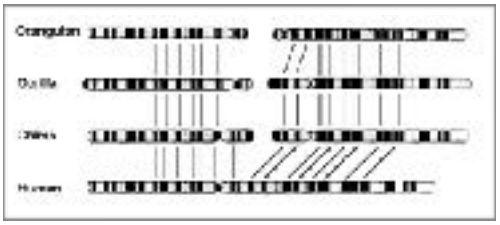
This is how regular reproduction occurs, a well-characterized process taught in high-school. It is also where the mechanism of speciation occurs, a still-speculative process. We can be sure that this is where it occurs, however, by looking at the chromosomal alteration that often separates a parent species from a daughter species where chromosome number is a barrier to species interbreeding.

An example are the closely-related horse with 64 chromosomes and donkey with 62 which can have offspring together. A male horse and a female donkey have a hinny. A female horse and a male donkey have a mule. Both, however, are sterile and cannot have further offspring A mule gets 32 horse chromosomes from mom and 31 donkey chromosomes from dad for a total in the zygote of 63 chromosomes. This is viable and develops because, in mitosis, there is no matching up into a tetraplex so the lone horse chromosome is fine and the genetic contributions are compatible so the zygote develops.

In meiosis, however, all the same chromosomes need to match up in a very particular way in the tetraplex with all the four chromosome lined up together. But this can't happen in a mule or hinny because there is no match for the extra horse chromosome. Meiosis stalls, no gametes are formed, and because chromosomes can't find their partners this causes the sperm and eggs not to get made. The horse and donkey species remain isolated.

[1] For more information and reference see: www.nature.com/scitable/topicpage/meiosis-genetic-recombination-and-sexual-reproduction-210

A similar situation must have arisen somewhere in the history of the human lineage when it separation from that of the Great Apes, our closest extant species. Humans have a characteristic diploid chromosome number of 2N=46 whereas the Great Apes (orangutans, gorillas, and chimps) are all 2N=48. Detailed examination of the many genetic markers we have in common, reveals that the large human chromosome-2 with its centromere near the middle is the fusion of two small Great Ape chromosomes with centromeres near the ends. Such a fusion must have occurred during recombination in one of our distant ancestors.[1]



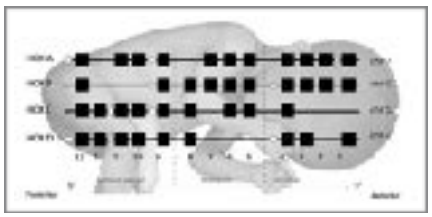
Digital Reorganization

Returning to the digital world of computers, once we left behind the era of 400k discs and enterer the age of hard drives that could store 5MB, 10MB, and more, a problem with fragmentation arose, where important information, such as this missive, is stored in whatever space is available, which over time, caused problems in the retrieval of digital information. The solution was to run a defragmentation program which would consolidate the data.

In the early days of the modern synthesis, it was thought that random mutations, random changes in the digital recipes for protein, were the changes that were thought to be the random variations that were sifted by natural selection.

It later became clear that such mutations were a minor theme in evolution, and that chromosomal structure and control of genes were much more significant significant. This became apparent with the discovery of the HOX genes in the fruit fly. While not so apparent in sophisticated animals, the segmentation that is very apparent in the earthworm played a major role in evolution and still does in the development from a single-cell zygote to the adult form. In the human body, for instance, this can clearly be seen in the structure of the spine. The HOX genes are central to the process of segmentation in the developing embryo.

The HOX genes control what segments of the fruit fly will develop into head, winged thorax, and abdomen. The HOX genes are arranged on the chromosome in exactly the same order that the segments the order appear in the fly body. Duplication of the thorax HOX, will result in a fly with two sets of wings. Other abnormalities, such as legs on the head, are created by changes in the HOX gene order of the chromosome.



While the fruit fly has only one set of HOX genes, the human has four such sets on different chromosomes that work in tandem. The same ordering from tail to head still applies. Errors in the human HOX genes usually result in a non-viable fetus.

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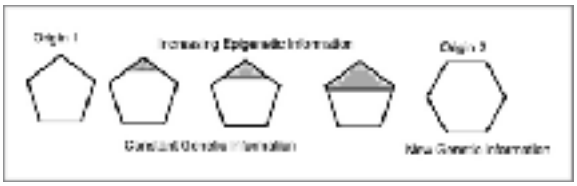
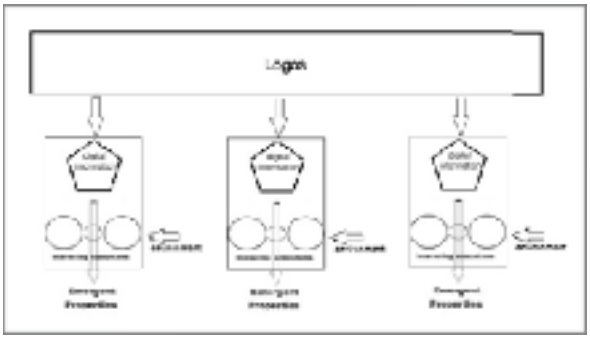
[1] www.mun.ca/biology/scarr/Human_Ape_chromosomes.htm

Ancestral Wisdom

Over a history of many generations, however, a lineage can accumulate a great deal of wisdom about the environment they are living in. This is epigenetic information written onto the genetic information, information that can influence the reorganization of the genetic information during recombination as the sex cells are being generated. This is similar to the defragmentation of of a computer store.



As the environment is a reflection of the Logos, of natural law, this accumulated wisdom is garnered from the Logos. This is how the Logos can imprint its structure into the long-term digital memory of the genetic system. This is the mechanism of speciation, the origin event of a new species, an aspect that is not present in regular reproduction.



So the origin aspect of living systems directly involves the Logos, as it does in non-living systems. During this the information from the Logos is transferred from the short-term epigenetic level to the long-term genetic level.

Unlike non-living systems, the multiplication step of living systems is different. The genetic information is passed down the generations, and it is this that directs the interacting subsystems to express indirectly the emergent properties inherited from the Logos.

This view has all the advantages of the modern synthesis but replaces the concept of random variation with accumulated learning by a lineage.

The model has to be developed to include the origin of male and female, a pair-production mechanism, that can establish a lineage that is reproductively successful.

SEQUENTIAL EDENS IN COSMIC HISTORY

Evolution from nothing devoid of systems implies a sequence of origin events when the first of a system makes its appearance All scientists—and religionists for that matter—agree on at least one point: the Universe started simple with an absence of sophisticated systems. The Bible states that in the first instant there was only light; while science asserts a 1 in one hundred billion impurity of legions and nucleons. Contemporary science insists that evolutionary history from this simple origin is not teleological, that the doctrine of design and purpose in the material world is false. This dogma insists that every step in development in the history of life—from its abiotic beginnings to humans—must stand on its own merit in the struggle for survival. If is not useful *now* then it cannot survive to be useful *latter.*

The Logos of Unification Thought suggests otherwise—sometimes an aspect emerges that is not useful now but has a role to play in later developments. If we start with a universe containing none of a system, and later it contains many of a system, then clearly at some point in the interim there must have been the very first of the system to emerge in the universe

The purposeful nature of the Logos—with the advent of the human capacity as its goal—is exemplified is the sequence of edens in the history of the universe. The definition of a system-eden is the time and place where all the constituent subsystems are present, and the environmental circumstances are just right, for the very first of a system to appear in the history of the universe. This is an Origin Event. For example, the universe in both science and religion started with no hydrogen atoms. Nowadays there are plenty of them. So at some point in time the very first hydrogen atom emerged, followed by many others. The hydrogen-eden is the time and place when the the very first hydrogen atom appeared in the universe—the Origin Event for hydrogen atoms.

While this is logically true, science asserts that almost immediately following this Origin event, there emerged tens, thousands, millions, billions, trillions etc., of hydrogen atoms—the Origin event of the system was followed by multiplication of the system. It is here that we find the great divide between non-living and living systems: the Origin event and multiplication event of non-living systems are essentially the same; while they are fundamentally different in living systems.

For inorganic systems, the Origin Event is the same as the origin of all the myriad of other hydrogen atoms that soon appeared in the universe in the era of cosmic history called recombination. Even if the second atom, however, appeared a microsecond later, logically there must have been the very first one.

For living systems, however, the Origin Event is distinct from multiplication in which the captured digital information about analog form is duplicated, the process by which all the subsequent systems emerged.

Unification Thought states that development occurs through three stages:

1. Formation Stage (FS)—when the basic components appear and begin to interact under the guidance of the Logos.

2. Growth Stage (GS)—when new aspects of the Logos appear, actively interact and develop.

3. Completion (CS)—when the Logos is fully expressed and generates the eden for the next step towards the human.

We can distinguish at least a score of edens in the history of the universe. The first few involving the emergence of novel inorganic systems, while the rest involve the emergence of novel living systems on Earth.

We shall now examine each eden in sequence.

Spacetime-eden

The FS was a speck of negative vacuum created at time zero that exponentially inflated in the GS to create spacetime. The vast separation of quarks in the first picoseconds flashed into the Hot Big Bang of energy, slowing the rate of inflation, the CS and creating the eden for the next step in the expression of the Logo, the emergence of the fundamental particles out of which familiar matter is formed.[1] It is probable that the Dark Energy that nowadays is 70% of the universe also emerged at this time, but as this is currently a known-unknown so we will not discuss it. This occurred about 13.5 billion years ago.

Particle-eden

The FS of the particle eden was the dense, ultra-hot energy of the Hot Big Bang quantized into every and all of the particles and antiparticles in the currently-understood zoo of modern fundamental physics. The GS was the cooling of the still-expanding—albeit much slower—spacetime just created. As the cooling advanced, heavy particles relaxed into lighter particles, particles and antiparticles annihilated, until all that remained was a plethora of photons and a sparkling of matter particles. It remains a mystery of how the annihilation was not not absolute and *how* the Logos allowed a tiny amount of matter to survive this period. The *why* it happened is obvious as humans need matter for a physical body.

The GS complexities of the Hot Big Bang were essentially over after 3 minutes[2] resulting in a vast number of gamma ray photons with a $1{:}10^{11}$ 'contamination' of electrons, protons (75%) and helium nuclei (25%). It is probable that the Dark Matter that nowadays is 25%% of the universe also emerged at this time, but as this is also currently a known-unknown so we will not discuss it, and just deal with the 5% of regular matter that is currently well-understood by science.

The Gamma ray photons, stretched by the continuing expansion and gradually losing energy resisting the Universe's expansion, are nowadays the low energy Cosmic Microwave Background

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[1] Tyson, Neil deGrasse and Donald Goldsmith (2004), Origins: Fourteen Billion Years of Cosmic Evolution, W. W. Norton & Co., pp. 84–5.

[2] Steven Weinberg, *The First Three Minutes: A Modern View of the Origin of the Universe,* Basic Books 1977

(CMB) photons[1] that pervade all of space, while the regular matter is still ~75% hydrogen and 25% helium. This is the CS that provided the seeds of the next step, the eden that allowed for the emergence of atoms in the Universe.

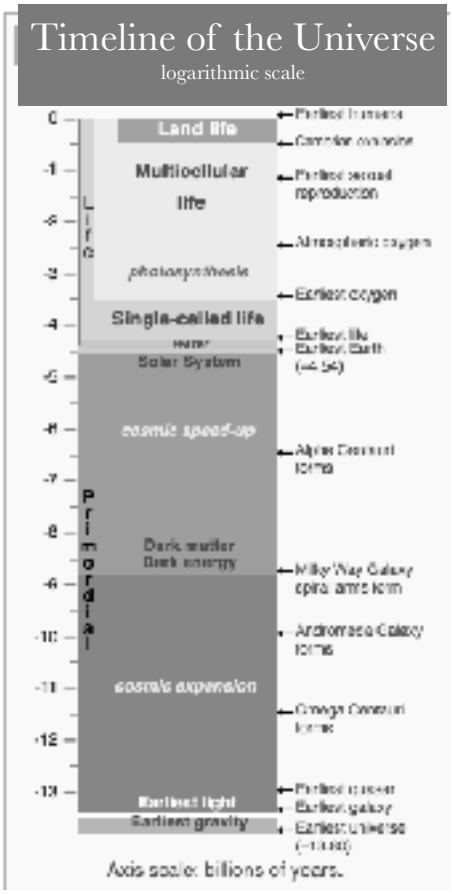
Hydrogen-eden

The FS was a hot plasma of gamma photons that prevented any protons and electrons from sticking together. For about 1/2 million years after the Big Bang, the universe was too hot for any atoms to form, but the expansion of the Universes, the GS, sapped energy from the photons and they shrank to X-ray, then UV, then blue, red, IR photons and on down.While UV photons could disrupt them, the blue could not, and protons and electrons could stick together as hydrogen atoms, and electrons and helium nuclei could bind as helium atoms.

The first, then a multitude of hydrogen and helium atoms appeared in the Universe. This was the CS that set the stage for the next eden in which the elements essential for life—carbon, oxygen, nitrogen, sulphur, phosphorus, iron etc.—and the elements essential for the background for life—silicon, aluminum, etc.— were created.

Metals-eden

Unlike the chemists, astrophysicists classify all the elements in the Periodic Table—excepting the primordial hydrogen and helium—as 'metals'. Metals were not created in the Big Bang eden, they emerged much later. Although the details are obscure, when the universe was less than a billion years old,[2] the primordial hydrogen/helium had gravitationally coalesced in to galaxies and the first generation of stars.



"Theorists predict that the clouds of gas in the early universe would have remained relatively warm from the big bang and so would resist condensing down to form stars. Mixing in a small amount of heavier elements helps gas clouds cool, because those elements are easier to ionize and so shed heat as radiation. But those heavy elements hadn't yet formed in the early universe, so stars grew to enormous sizes—hundreds or even a thousand times as big as our sun—before their cores were dense enough to spark fusion. Once they did get started, they burned fast and hot, emitting lots of ultraviolet light and burning out in a few million years"[3]

It is in the cores of these 1st-generation stars that hydrogen fused to helium. It is the energy released by this fusion that fuels

[1] http://planck.cf.ac.uk/science/cmb

[2] http://firstgalaxies.org/explore.html

[3] http://www.sciencemag.org/news/2015/06/astronomers-spot-first-generation-st

the stars on the Main Sequence.[1] Leaving the Main Sequence, the stars entered the final, and much shorter, stage of a red giant when helium fused to carbon[2] and oxygen, and so on up to iron. This is the GS in the creation of the non-primordial elements in the Periodic Table.

The formation of iron, however, is the death knell for a star as fusion can no longer generate energy. The death throes of a giant star is a supernova—brighter than an entire galaxy of billions of stars—that scatters the metals formed within the star into the interstellar medium to participate in the formation of the 2nd- and 3rd-generation stars. This hyper-explosion is so energetic that it forces nuclei together to create all the elements more massive than iron.

This is the CS where 'metals' appear in the interstellar gas out of which new stars form. The 2nd generation were less massive, and the 3rd generation—of which our Sun is a member—smaller still and with lifetimes in the billions of years. This is the CS that set the stage for the emergence of life.

Sufficient metals were in the gas that condensed into the solar system to allow rocky planets—such as the Earth—to form. This was the creation of the eden for life to emerge, and our focus shifts from the Universe as a whole to this specific planet.

Life eden

About 4.5 billion years BP, our Sun condensed along with its suite of planets. The details of this FS in the formation off the Earth, the eden of life, are still a matter of debate:

"The question of the origin of the solar system is one that has been a source of speculation for over a hundred years; but, in spite of the attention that has been devoted to it, no really satisfactory answer has yet been obtained. There are at present three principal hypotheses that appear to contain a large element of truth, as measured by the closeness of the approximation of their consequences to the facts of the present state of the system, but none of them is wholly satisfactory."[3]

One this is weird is very clear, however, it is the presence of the Moon that makes the Earth the eden for the emergence of living systems; for without it the Earth would be quite different—less benign and more hostile.[4]

Evidence is accumulating that the Moon formed when a Mars-sized planetoid collided with the early earth. "At the time Earth formed 4.5 billion years ago, other smaller planetary bodies were also growing. One of these hit earth late in Earth's growth process, blowing out rocky debris. A fraction of that debris went into orbit around the Earth and aggregated into the Moon."[5]

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[1] http://www.atnf.csiro.au/outreach/education/senior/astrophysics/stellarevolution_mainsequence.html

[2] This involves the Triple Coincidence described in the discussion of the Logos.

[3] https://www.scientificamerican.com/article/the-origin-of-the-solar-system/

[4] Neil F. Comins *What If the Moon Didn't Exist?: Voyages to Earths That Might Have Been*

[5] https://www.psi.edu/epo/moon/moon.html

There is another aspect of the Earth that makes it conducive to life, that is the plate tectonics that slowly reconfigures the Earth's surface, creates mountains and volcanoes. At the plate boundaries there heat and material for deep inside escapes in a variety of "smokers" that many suggest were crucial to life's origin, as discussed in the following section. There is no consensus as to why Earth has tectonics while the similar planets of Venus and Mars do not: "When and how plate tectonics started is a key question among geologists. Some researchers think it started more than 4 billion years ago, and others say it started only about 1 billion years ago. That's a big range, and the uncertainty stems from the fact that it's simply hard to find well-preserved ancient rocks."[1]

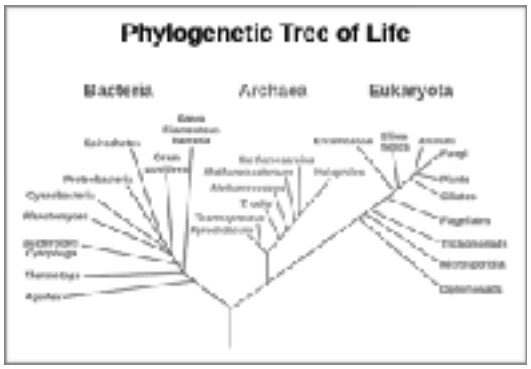
One possibility is that the immense collision that splashed off the Moon also fragmented the surface of the Earth, creating the tectonic plates that slowly migrate across the globe. Without the Moon, history might have been akin to Venus, where the lack of surface fractures allowed a buildup of internal pressure that was released in a global vulcanism that obliterated the entire surface: "Venus underwent a global resurfacing event 300–600 [million years] ago, the cause and nature of which remains uncertain. The present-day surface heat flux on Venus is about half the likely radiogenic heat generation rate, which suggests that Venus has been heating up since the resurfacing event."[2]

This tumultuous GS period, the Hadean time (4.6 to 4 billion years ago) ended as the planet cooled, the Earth's crust formed, the oceans condensed out, the CS and the establishment of the eden for living systems to emerge.

Proto-life eden

The tumultuous birth of the Earth/Moon system ended ~4,400 million years ago as the oceans were established. Scientists assumed, at first, that the transition from the FS chemical era to the GS biochemical era must have been unlikely and taken eons to occur. Thus it came a quite a shock when signs of living systems were found in rocks that were 4,300 million years old. This was a consequence of the Logos which, to the contrary, made the Origin of Life a probable, not improbable, event. While there is still much debate as to the sequence and location of the events that organized simple chemicals into a living organism[3]—*life* being a quality inherited form the Logos—the end result was the last universal common ancestor (LUCA) from which all past and extant life is descended.

As chemical energy was required to drive this development, a well-accepted theory is that the edens for these events were the volcanic hydrothermal vents, the black and white *smokers* found today along the tectonic plate boundaries spewing high-energy compounds into the cool ocean: "Hydrothermal vents — where heated, mineral-laden seawater spews from cracks in the ocean crust — created a gradient in positively charged protons that served as a "battery" to fuel the creation of



[1] https://www.livescience.com/31570-plate-tectonics-began.html

[2] F. Nimmo and D. McKenzie, Annu. Rev. Earth Planet. Sci. 1998. 26:23–51

[3] An excellent overview of this area of research in in Christian de Duve's *Vital Dust* pp, 15-51

organic molecules and proto-cells."[1]

The LUCA is estimated to have lived some 3.5 to 3.8 billion years ago[2] and had the basic aspects shared by all current life: It used the universal triplet code to store digital information; It used ribosomes to translate this information into proteins using the universal set of 20 amino acids; It was enclosed by a lipid bilayer membrane; It generated ATP using chemiosmosis—ion gradients across the membrane; It divided after duplicating all its contents. The LUCA lineage was the CS of basic life, and diverged over time to generate the three great domains of life: the bacteria, the archaea and the eukaryota—elucidated by ribosomal structure.[3]

These days, the archaea flourish in conditions similar to those found on the early Earth—hot, acidic, salty, sulfurous, etc.—considered hostile and avoided by all other living organisms. The bacteria are everywhere else and essentially unchanged. In the 1500 million years following LUCA they transformed the Earth by generating an oxygen atmosphere as well as creating an eden for the eukaryotes to emerge, setting the stage for the expression of the sophisticated levels of the Logos as plants and animals. The diagram illustrates roughly the current consensus as to the Earth's history using a scale of millions of years before present.

Eukaryote eden

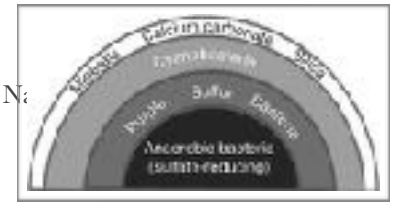
Both the bacteria—technically the *eubacteria*—and the archaea are prokaryotes, the are characterized by a lack of internal organelles, especially the nucleus. The main metabolic challenge facing living organisms is adding hydrogen to carbon dioxide to generate carbohydrates which are the basis for every other type of molecule. The challenge is to find a source of hydrogen, and to obtain sufficient energy to drive the reaction. While early metabolism probably reduced CO_2 to sugar using hydrogen sulphide as a sources of hydrogen (laying down the ancient beds of sulphur mined today) and chemical energy such as thioesters.
Eventually the Logos guided the development of a metabolic pathway that used the ubiquitous water molecules as a source of hydrogen and the capture of red and blue light energy to drive the reaction. The discovery of photosynthesis, which uses the energy of the abundant light quanta emitted by the Sun to separate water into hydrogen and oxygen, liberated bacteria from their dark origins to populate the oceans.

The oxygen liberated by the photosynthetic bacteria was first absorbed by the ocean's soluble ferrous iron which converted to insoluble ferric iron which precipitated out as the immense *banded iron* deposits which are the source of modern-day iron ore: "We know there was some free oxygen in the

[1] https://www.livescience.com/26173-hydrothermal-vent-life-origins.html

[2] Theobald DL (May 2010). "A formal test of the theory of universal common ancestry". Na

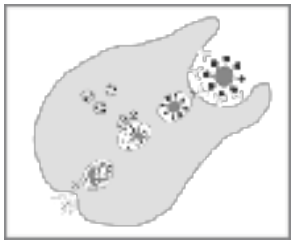
[3] https://en.wikipedia.org/wiki/Last_universal_common_ancestor



atmosphere by 2.3 or 2.4 billion years ago, but it took until around 2 billion years ago, after 700,000,000 years of work by the cyanobacteria, for there to be enough oxygen in the atmosphere to think of it as relatively oxygen rich. For a while, a few hundred million years, the highly reactive oxygen given off by photosynthetic organisms probably combined with iron dissolved in the early oceans, so oxygen didn't accumulate in the atmosphere. It produced thick iron oxide deposits like those in Minnesota…"[1]

While many photosynthetic bacteria floated free in the primordial ocean, some remained attached after division which lead to the formation of stromatolites. These are layered bacterial structures that occur widely in the fossil record of the Precambrian, > 600 Million years BP, but are rare today. "Modern stromatolites are mostly found in hypersaline lakes and marine lagoons where extreme conditions due to high saline levels prevent animal grazing."[2]

The layering of the stromatolites has the primary producers photosynthesizing in the top layer. Their dead bodies feed the lower layers. It as probably in such a protected environment that some prokaryotes could shed their protective coating and adopt phagocytosis—feeding by engulfing food with the now-freed flexible membrane. Modern day freely-living amoeba and the macrophages in our blood still use this ancient method to respectively feed and clear the blood of bacteria and debris. Rather than an outer coat, an internal network of protein filaments was developed to control the cells structure:



"The cytoskeleton is composed of three distinct elements: actin microfilaments, microtubules and intermediate filaments. The actin cytoskeleton is thought to provide protrusive and contractile forces, and microtubules to form a polarized network allowing organelle and protein movement throughout the cell. Intermediate filaments are generally considered the most rigid component, responsible for the maintenance of the overall cell shape."[3]

Other steps in this stromatolite eden were the enclosure of the DNA in a bi-lipid membrane—the origin of the nucleus—the symbiosis with an ingested but not digested prokaryote that could utilize oxygen efficiently—the origin of the mitochondria—and for a later lineage, a similar symbiotic relationship with a photosynthesizing prokaryote—the origin of the chloroplasts. These two examples are of *endosymbiosis:*

"The endosymbiotic origin of mitochondria and chloroplasts is widely believed because of the many similarities between prokaryotes and these organelles: 1. Mitochondria and chloroplasts are similar in size and shape to prokaryotes 2. They have their own DNA that lack histone proteins, is circular, and attached to the inner membrane as is the DNA of prokaryotes 3. Their ribosomes are more similar in size to prokaryotic ribosomes 4. They divide by fission, not mitosis. 5. Mitochondria arise from preexisting mitochondria; chloroplasts arise from preexisting chloroplasts (they are not manufactured through the

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[1] http://historyoftheearthcalendar.blogspot.com/2014/01/january-19-oxygen-crisis-2-billion.html

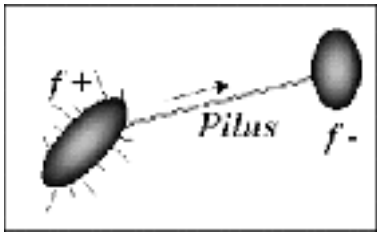
[2] https://en.wikipedia.org/wiki/Stromatolite

[3] https://www.ncbi.nlm.nih.gov/pubmed/15180824

direction of nuclear genes). 6. Their outer membrane would have been synthesized by the original "host" cell and used to engulf the endosymbiotic bacteria that became the organelles. Their outer membrane has structural and chemical similarities to the eukaryote cell membrane."[1]

The end result of this long development GS was the eukaryote cell, a lineage that later developed into all the non-bacterial forms of life: fungi, plants and animals.

Origins of Sex



Asexual reproduction is simple, the DNA is duplicated and the cell divides each half getting a set of DNA: "Though bacteria are predominantly asexual, the genetic information in their genomes can be expanded and modified through mechanisms that introduce DNA from outside sources. Bacterial sex differs from that of eukaryotes in that it is unidirectional and does not involve gamete fusion or reproduction."[2]

Eukaryote sex is mutual, involves gamete fusion, and is central to reproduction while the passing on of mitochondria and chloroplasts is uniparential, solely through the maternal lineage: "Sexual reproduction is a nearly universal feature of eukaryotic organisms. Given its ubiquity and shared core features, sex is thought to have arisen once in the last common ancestor to all eukaryotes. Using the perspectives of molecular genetics and cell biology, we consider documented and hypothetical scenarios for the [origin] and evolution of meiosis, fertilization, sex determination, uniparental inheritance of organelle genomes, and speciation."[3]

One of the few extant eukaryotes that do not have endosymbionts—either mitochondria or chloroplasts —is *Giardia* that is probably a remnant of the earliest eukaryotes. Like many eukaryotes it is diploid—having two sets of essentially identical chromosomes. Unlike the others, however, these inhabit two separate haploid nuclei.

The advantages of the diploid over the haploid state is still a matter of debate[4] and many simple plants spend much of their life cycle in the haploid state. In all higher organisms, however, the haploid state is transitory while it is the diploid state that is predominant.

Multicellular eden

In the discussion so far, we have been dealing with single cell— observed in the characteristic plaques generated on petri-dish agar by bacteria in the lab today— or colonies of single cells such as the stromatolites. Such colonies are not considered multicellular as all the members are identical clones. While the history of life's development of Logos-related structures so far has covered over 3 billion years, all this occurred in the world ocean. The challenges of populating dry land were such that it only multicellular organisms—characterized by cells differentiated into a variety of forms dealing

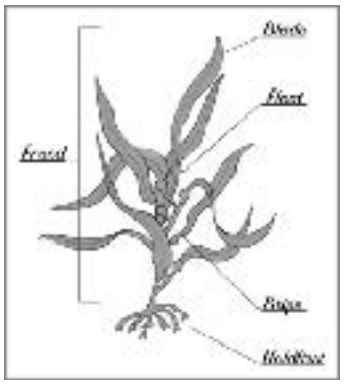
[1] https://www2.gwu.edu/~darwin/BiSc151/Eukaryotes/Eukaryotes.html

[2] http://www.sciencedirect.com/science/article/pii/S0960982206019725

[3] http://cshperspectives.cshlp.org/content/6/3/a016154.full

[4] http://www.genetics.org/content/156/2/893

with different aspects of the challenge—that could accomplish this feat. The eukaryote lineages of autotrophs and heterotrophs diverged as multicellular forms were explored:



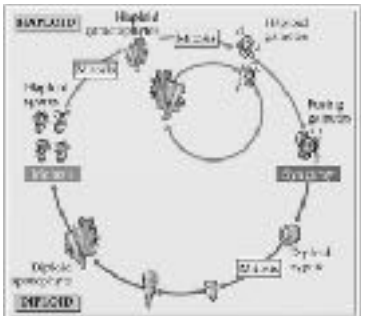
"Multicellular eukaryotic forms of life probably arose initially from small clones of cells that remained associated after their production, by successive divisions from a single parental cell. The cells were held together either by intracellular connections or by a shared external wall or shell. Roughly speaking, the former mechanism led led to animals and the latter to plants and fungi"[1]

In this era, the oceans would have hosted a plethora of photosynthetic and scavenger eubacteria—the archaea thriving only in the remnants of the hadean era—and photosynthetic and scavenger eukaryotes, the protists common in the ocean and ponds to this day. The photosynthetic cyanobacteria—in an earlier time called the blue-green algae for their habit of sticking together in long chains—were probably the first to explore the advantages of creating a colony of clones.

Seaweed eden

It was probably in the tidal littoral zone—where the sea first covered then exposed—that plants discovered the advantages of sticking to one place. At one end of the clonal chain, cells secreted chemicals that fixed them to the rocks—the holdfast of seaweeds—and others created buoyant floats that lifted the fronds to the light—while the remaining cells spread out and focused on photosynthetic growth. In this littoral eden the seaweeds perfected themselves and have little changed since. As this mode was eminently suited to the ocean, this was as sophisticated as multicellular eukaryotic plant life developed in the ocean; an example of the truism: "If it ain't broke, don't fix it."[2]

The exploitation of the heretofore barren dry land began with the simple mosses that often spend half of their lifecycle in the haploid state—the diploid and haploid stages looking very similar to each other. This is called *alternation of generations:*



"In this life cycle, a haploid organism (the gametophyte) produces gametes by mitosis. These gametes fuse in a fertilization event, creating a diploid zygote. This diploid zygote divides (typically) mitotically to produce a multicellular diploid offspring. This organism produces haploid spores by meiosis. These spores develop, dividing mitotically to produce the next multicellular haploid generation. So, the ploidy level 'alternates' across the generations. In green algae, the sporophyte and gametophyte stages may be 'isomorphic' (look the same)…"[3]

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[1] Christian de Dove, *Vital Dust,* BasicBooks 1995, p.176

[2] http://idioms.thefreedictionary.com/if+it+ain%27t+broke%2C+don%27t+fix+it

[3] http://facweb.furman.edu/~wworthen/bio111/plant1.htm

Moss eden

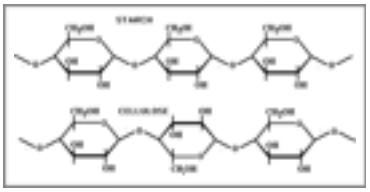
The advance of plant life onto dry land was progressive, following a gradient in the marshy land near water, as new skills were inherited from the Logos. The first skill was to avoid desiccation by developing a waxy covering with openings—primitive stomata—for CO_2 to enter and O_2 to depart. Not being blown away from water was also a needed skill provided by roots. Finally, reproduction without cells traversing open water was necessary, and tough coatings allowed haploid spores to disseminate with the wind and germinate when water was found. The haploid plants produced motile male and immobile female gametes which could meet, fuze, grow and generate haploid spores.

A green carpet extended from open water onto the previously barren land. These days there are some 15,000 species of moss exploiting a plethora of ecological niches.

Land plant eden

While greatly different in its outer reaches, the metabolism of all living systems is the same at the central core where carbohydrates activated by phosphate are manipulated. Plants create carbohydrates by capturing energy from sunlight; fungi and animals obtain energy by breaking down carbohydrates. Their name suggests that carbon and water are united, but this is a misnomer: plants use energy to strip hydrogen from water (liberating oxygen) and add it to carbon dioxide. Animals strip the hydrogen and add it oxygen (recreating water) liberating energy and carbon dioxide.

In plants, light energy is used to generate molecules of ATP and NADPH (activated hydrogen)—the the light-dependent reactions. To make a molecule of glucose in the the light-independent reactions, six CO_2 molecules are hydrogenated by twelve NADPH driven by the energy liberated by the breakdown of eighteen ATP in a complex cycle of transformations known as the Calvin Cycle.[1]



While carbohydrates are the feedstock for generating amino acids, fats, nucleotides and all the other molecules that plants manufacture, glucose itself is used directly to generate two important macromolecules, starch and cellulose. The great difference between these two molecules is the way the glucose monomers are linked together. The seemingly insignificant difference, as illustrated, determines two very different properties inherited from the Logos; starch being the edible stuff of potatoes, flour and white rice—cellulose being the inedible-to-animals[2] tough fibers of grass, leaves and wood.

The toughness of cellulose was utilized in the next step of plant evolution as the process of vascularization was learnt from the Logos. Moving away from free water was only possible for plants with deep roots that could tap water underground, a location that precluded photosynthesis. Connecting the colorless roots and the green leaves were connecting stems, strengthened by cellulose with uni-directional xylem tubes transporting water and minerals upwards, and phloem tubes transporting photosynthetic products downwards.

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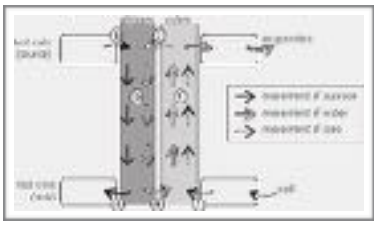
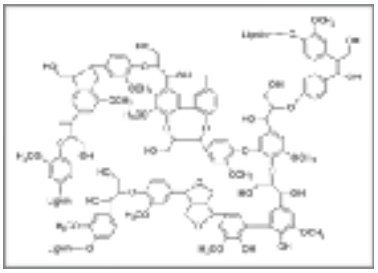
[1] https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-calvin-cycle-reactions/a/calvin-cycle

[2] Herbivorous animals harbor symbiotic bacteria that can break down the cellulose for their hosts. Termites do the same thing with wood.

"Surprisingly, the exact mechanism of sugar transport in the phloem is not known, but it is certainly far too fast to be simple diffusion. The main mechanism is thought to be the mass flow of fluid up the xylem and down the phloem, carrying dissolved solutes with it. Plants don't have hearts, so the mass flow is driven by a combination of active transport (energy from ATP) and evaporation (energy from the sun)."[1]



The vascular plants, unlike the mosses, developed a diploid mature phase while the haploid stage was reduced to a short stage, often underground, of generating gametes that fused into a diploid zygote that developed into the mature plant.



About 400 million years ago, these developments allowed plants to cover the land in green and soil. With the discovery of lignin, a tough multi-linked polymer that strengthened cellulose, solid trunks allowed trees to grow to 40 feet or more. As it took the bacteria and fungi time to learn how to digest lignin, the dead remains of these plants were not degraded but eventually fossilized creating the massive beds of coal found worldwide. In consequence, the period between 360 and 286 million years ago is called the Carboniferous era.

Conifer eden

During the Carboniferous, the tectonic plates had been slowly been rearranging the continents. This productive era drew to a close as when all the continents came together as one, called Pangaea, whose center turned a vast, arid desert. Much of this supercontinent was centered on the South Pole covered with a huge ice sheet deep, and the ocean level dropped In the same period, the massive volcanic eruptions in what is now Siberia generated great dust clouds, cooling the Earth globally, and the Earth entered the bleakest ice age.

This was the start of the Permian Age and a wave of extinctions called the Permian Extinction: "a series of extinction pulses that contributed to the greatest mass extinction in Earth's history. … The Permian extinction was characterized by the elimination of over 95 percent of marine and 70 percent of terrestrial species. In addition, over half of all taxonomic families present at the time disappeared. This event ranks first in severity of the five major extinction episodes that span geologic time."[2]

Plants reacted to this challenge by reproducing by resistant seeds, rather than venerable spores. Extant species developed during this challenging period are the ginkgoes, pines, spruces, redwoods and

[1] http://www.biologymad.com/master.html?http://www.biologymad.com/planttransport/planttransport.htm

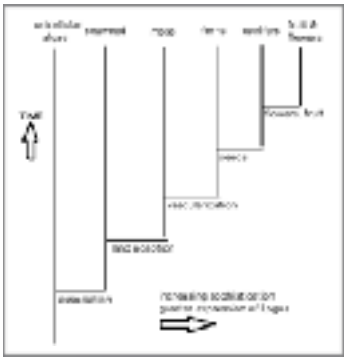
[2] https://www.britannica.com/science/Permian-extinction

other conifers. This was the harsh eden in which the superfamily of gymnosperms developed which, to this day, thrive in subarctic climates close to the poles or in the higher elevations of mountain ranges.

Fruit & flowers eden

About 100 million years ago, Pangaea had moved northwards and divided into the familiar continents and were moving into the configuration of today's globe. Fossil evidence indicates that flowering plants first appeared about 125 million years ago, and were rapidly diversifying by 100 million years ago. The flowers were a sign of the symbiosis between flowers—that rewarded with sugars—the insects that carried pollen away to other flowers.

Along with this came to development of fruits, enveloping the seeds; flowers and fruit being the defining characteristic of the other superfamily of angiosperms, basically all familiar plants that are not conifers.



Fruits develop a process unique to plants: double fertilization. One pollen arrives and sends a male haploid gamete to unite with with a haploid female gamete to generate the zygote seed that will develop into a new plant. A second pollen unites with a diploid cell in the female ovary—creating a triploid cell—which multiplies into the fruit which surrounds the seed. The fruit initiated another mutual relation with animals that, attracted and feeding on the fruit, spread the sees far and wide.

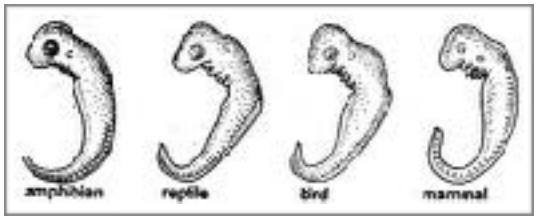
The diagram illustrates the history of the major innovations learnt from the Logos by the ancestral eukaryote.

Along with the plant invasion of dry land came a army of scavengers related to yeast and lacking chlorophyll. Unlike animals there were not mobile, reproduced by spores and relied on extracellular digestion. This was the origin of the fungi now encompassing over 200,000 different species, including the delicious mushrooms enjoyed by multitudes.

As both herbivorous and carnivorous animals ultimately depend on plants to generate food from air, water and sunlight, the invasion of land by animals of necessity followed that of the plants. While the plants never really progressed beyond seaweed in the ocean, the progressive sophistication of the animals took many steps in the ocean before attempting to follow the plants onto dry land.

Animal ontogeny and phylogeny

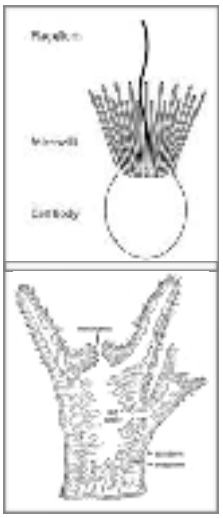
It is probably the complexity involved in the transition from a single-cell zygote to a intricate adult, but but both animal evolution and development are remarkably conservative. Whatever steps occurred in the ancestral lineage are repeated, at least ephemerally, in the steps of development from a single-cell zygote to multi-cell adult. This is summarized as: " 'Ontogeny recapitulates phylogeny' a catchy phrase coined by Ernst Haeckel, a 19th century German biologist and philosopher to mean that the



development of an organism (ontogeny) expresses all the intermediate forms of its ancestors throughout evolution (phylogeny)."[1]

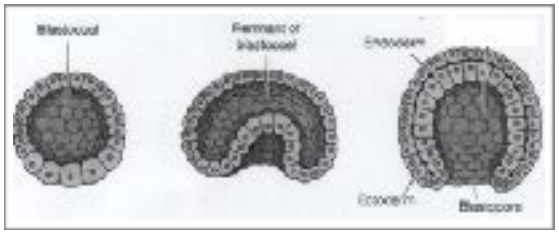
The evolution and development of the human form are central to the Logos, and all body plans are variations on this basic pattern. In fact, in the earliest stages of all animal development—the embryo—it is almost impossible to tell who will develop into an amphibian, reptile, bird or mammal.

Body plan eden



While survivors of the earliest days still remain today, it must be remembered that their ancestral lineages have hundreds of millions to develop and improve on their basic plan. With this in mind, an example of a sophisticated single celled heterotroph is the choanoflagellates, here illustrated, that are found all over the word in water environments where the play a key role in the microbial population: "In addition to their critical ecological roles, choanoflagellates are of particular interest to evolutionary biologists studying the origins of multicellularity in animals. As one of the closest living relatives of animals, choanoflagellates serve as a useful model for reconstructions of the last unicellular ancestor of animals."[2]

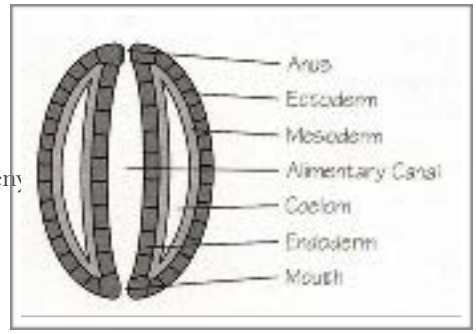
Such cells joined into spherical associations that combined cooperative propulsion and feeding, and with the development of internal channels became the sponges of our era. Invagination created a cavity for more entrapment and leisurely digestion, and this eventually developed into a primitive gut lined with endothelial cells, with ectoderm cells on the outside. This two-layers of cells is the diploblast pattern found in simple animals such as the hydra ubiquitous in ponds. This reproduces by budding off miniature copies of itself and the single opening serves as both a mouth to introduce prey to the gut cavity and an anus to rid it of undigested detritus.



In the development of the human zygote, ontogeny recapitulates phylogeny as the single cell first multiplies forming a hollow sphere of cells which then invaginates in gastrulation to form a double layered sphere, the gastrula, with a single opening, the blastopore. The ectoderm will eventually develop into the skin and nervous system et al, while the endoderm into the gut lining, the liver and the lungs et al.

There were two major advances that followed, and it is currently unknown in which order they occurred historically: 1. A second opening developed, the first remained a mouth into which prey were ingested, while the second became an anus out of which undigested detritus was expelled. 2. A third layer of cells, the mesoderm, developed between the ectoderm and the endoderm surrounding an internal space called the coelom.

This is the triploblastic pattern that is the basis for most animal



[1] http://2000clicks.com/graeme/langwisdomsayingontogenyrecapitulatesphylogeny

[2] http://tolweb.org/Choanoflagellates/2375

life. It is an important step in the development of the embryo: “The mesoderm is the middle of the three germ layers, or masses of cells (lying between the ectoderm and endoderm), which appears early in the development of an animal embryo. In vertebrates it subsequently gives rise to muscle, connective tissue, cartilage, bone, notochord, blood, bone marrow, lymphoid tissue, and to the epithelia (surface, or lining, tissues) of blood vessels, lymphatic vessels, body cavities, kidneys, ureters, gonads (sex organs), genital ducts, adrenal cortex, and certain other tissues.”[1]

Examples of descendants of such primitive triploblasts are the flatworms, nematodes and the parasitic tapeworm and ascaris. Currently, the best understood animal is the nematode *Caenorhabditis eleegans:* “Around the world thousands of scientists are working full time investigating the biology of C. elegans. Between October 1994 and January 1995, 73 scientific articles about this creature appeared in international science journals. Currently an international consortium of laboratories are collaborating on a project to sequence the entire 100,000,000 bases of DNA of the C. elegans genome…. C. elegans is about as primitive an organism that exists which nonetheless shares many of the essential biological characteristics that are central problems of human biology. The worm is conceived as a single cell which undergoes a complex process of development, starting with embryonic cleavage, proceeding through morphogenesis and growth to the adult….All 959 somatic cells of its transparent body are visible with a microscope, and its average life span is a mere 2-3 weeks. Thus C. elegans provides the researcher with the ideal compromise between complexity and tractability.”[2]

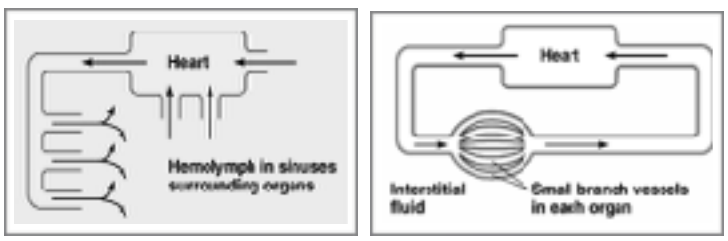
It was the triploblastic pattern that, under the guidance of the Logos, was the basis for the proliferation of animal body patterns that appeared in the Cambrian explosion of life 600-520 million years ago, whose fossils deposited in Canada were the topic of *Wonderful Life: The Burgess Shale and the Nature of History* by Stephen Jay Gould.

It was during this period of exploration of body patterns that a solution to the challenge of oxygen transfer and food distribution to internal tissues was discovered in the development of the *milieu interieur,* the bodily fluids regarded as an internal environment in which the cells of the body are nourished and maintained in a state of equilibrium. This involved learning three things from the Logos:

1. Simple gills, folded skin enabling efficient oxygen transfer from the ocean water.

2. The development of oxygen-carrying molecules such as the red hemoglobin, using iron, and blue hemocyanin, using copper.

3. Hearts to move the fluid about. In the earliest form this was just a thickening of the tube connecting to the coelom, an open circulation of hemolymph, and later the development of closed tubes with blood inside and lymph outside.



Open circulatory systems are still used by crustaceans, insects, mollusks and other invertebrates to pump hemolymph into a the

[1] https://www.britannica.com/science/mesoderm

[2] https://cbs.umn.edu/cgc/what-c-elegans

coelom where it diffuses back to the heart between the cells.

The closed system necessitated the development of thin-walled capillaries to allow exchange between the blood and lymph. This closed system is used by fish and all its more sophisticated descendants, the amphibians, reptiles, birds and mammals.

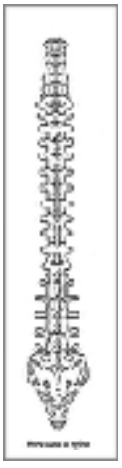
This was the completion stage of the basic animal blueprint for that followed.

Insect eden

The next great step in animal evolution was the Logos-directed duplication of the basic pattern followed by variation of the duplicates. The first multi-segmented animal looked like a set of worms all joined together. Each segment was essentially complete with only the external skin, the gut and blood vessels connecting them. At this time appeared a genetic innovation still active in all sophisticated animals: the regulatory homeotic genes, all sharing a highly-conserved 180-base sequence called the homeobox.

These homeotic genes control the duplicated segmentation "which represents a major mechanism of evolutionary diversification, perhaps the most important one in the history of life. It initiated an extraordinary combinational [process] involving complete, originally viable modules that could be mutated, fused, deleted and otherwise reshuffled, all by the magic stroke of a single or sparse genetic modification…"[1]

These simple segmented worms are extant as the annelid worms, the most familiar example being the common earthworm which has adapted to dry land, with a mouth in its anterior segment and an anus in its posterior segment.



The differentiation of the segments developed over time leading to whole classes of invertebrate animals that are predominant on Earth to this day—shrimps, lobsters, crabs et al in the ocean, and on land, insects, spiders, scorpions et al.

The fruit fly that seems to appear out of nowhere when ripe fruit is left lying around is the favored subject for geneticists. It was here that the homeotic genes were discovered. "Scientists discovered homeotic genes by studying strange transformations in fruit flies, including flies that had feet in place of mouth parts, extra pairs of wings, or two pairs of balance organs … instead of wings. Some even had legs growing out of their heads in place of antennae!"[2]

While it is difficult, nowadays, to discern the segmentation stage in human development, the clearest remaining representation of this aspect of the Logos in human development is our spinal column that, in the embryo, starts as the cartilaginous notochord that is calcified into the set of segmented vertebra.

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[1] Christian de Dove, *Vital Dust,* BasicBooks 1995, p.197

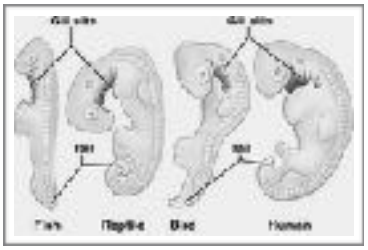
[2] http://learn.genetics.utah.edu/content/basics/hoxgenes/

The final change that opened up the possibilities of modern sophisticated animals was so strange that it can only be ascribed to Logos forward-looking to future development. The mouth end and the anus end switched places.

The insects and all the others remained as always, and are called the protostomes—the mouth-first organisms. The arthropods had the easiest transition to land already covered with an impervious chitin carapace. The only crucial step was to replace the external feathery gills with an internal set of ramifying tubes reaching bringing air to all parts of the body. This eventually led to the thousands of different insects and their relatives that rapidly followed plants onto land. As sucking plant liquids is not that different from sucking animal blood, mosquitoes and their ilk developed and have been a nuisance ever since.

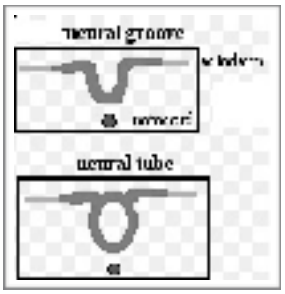
Fish eden

One lineage, however, switched the roles—with no discernible role in fitness as required by Darwin's random variation—so that the ancient anterior first-hole switched from being the mouth to the posterior anus—while the newcomer second hole, presumably not so set in its ways, switched from being the anus to become the anterior mouth. This homeotic Logos-guided 'flipped' deuterostome lineage became the ancestors to all vertebrate fish, amphibians, reptiles, birds, mammals and humans.



A consequence of this flip, still in evidence in simple acorn worms that have changed little over time, was that the anterior end became responsible for food and oxygen uptake. The front end developed into a set of gill slits and water taken in through the mouth was forced out through the slits that absorbed water and trapped food particles. These gill slits are clearly seen to this day in the embryonic development of all vertebrate embryos.

Another step was an infolding of the ectoderm along the dorsal skin which became a hollow tube a hollow tube running along the back, while below it a cartilaginous rod that is the —the notochord—that is the signal characteristic of all chordates that appears, if transiently, in all embryonic and some adult chordate animals. An extant form of this developmental stage are the lancelets, fish-like marine chordates with a global distribution in shallow temperate water, usually found half-buried in sand.



The next step was to surround both the neural tube and the notochord with segmented cartilage structures that protected the proto-spinal cord while remaining flexible. "The first vertebrates had cartilaginous bones and resembled worms more than fishes, having no jaw and only rudimentary fins. According to the fossil record, some will bizarre, ferocious-looking animals covered with armored plates. Their closest present-day descendants are the lampreys and hagfishes, which are very different from the remote relatives but share some primitive features with them."[1]

[1] Christian de Dove, *Vital Dust,* BasicBooks 1995, p.201

The next major advance learnt from the Logos was the formation of the hinged jaw by reforming the cartilage of propping up the foremost gill slits. With the development of fins supported by cartilage and the muscles to move them, the cartilaginous fish, a class distinguished by having a skeleton of cartilage rather than bone, including the sharks, rays, and sawfish.

The final and completion stage for fish was seeding the cartilage structures with calcium salts converting the cartilage into bone. Nowadays, about 90% of the world's fish species are of the bony fish class.

Up to this point in history, the only organisms to thrive on dry land were the plants, fungi and insects. Now it was the turn of fish to make the transition.

Fish out of water

The time-honored phrase, *fish out of water,* is an idiom used to refer to a person who is in unfamiliar, and often very uncomfortable, in new surroundings. This suggests the many challenges faced by the bony fish—gravity not supporting the cartilaginous varieties—in surviving in air and meagre water.

Sensibly, they did this in gradual stages, the first being the amphibious vertebrates, that spent intervals in both air and water, and have remained successful to this day. While the details of the transitional forms from fish to frog are still murky, it is widely accepted to have involved the lobe-fin fish:

"The most important features of lobe-finned fish is the lobe in their fins. Unlike other fish, Lobe-finned fish have a central appendage in their fins containing many bones and muscles. The fins are very flexible and potentially useful for supporting the body on land, as in lungfish and tetrapods (vertebrates with four limbs). Tetrapods are though to to have evolved from primitive lobe-finned fish."[1]

While prominent in the fossil record, it was thought for many years that relatively-direct ancestors had gone extinct until the fortuitous discovery of a living example, the coelacanth

"The coelacanth was thought to have become extinct 65 million years ago until its capture in 1938 by a South African museum curator on a local fishing trawler…. The most striking feature of this "living fossil" is its paired lobe fins that extend away from its body like legs and move in an alternating pattern, like a trotting horse. Other unique characteristics include a hinged joint in the skull which allows the fish to widen its mouth for large prey"[2]

The fossil record reveals much about the transition: "There is a sequence of fossils which occupy the transition from fish to amphibian. 378 MYR ago… These are lobe-finned fish. … The skull bones of these fish are bone for bone equivalents to the skull bones of the earliest tetrapods…. This fish also had lungs and nostrils … but also had gills. These things really looked like tetrapods until you see the fins."[3]

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[1] http://www.mesa.edu.au/fish/fish04.asp

[2] ibid

[3] http://chem.tufts.edu/science/evolution/fish-amphibian-transition.htm

Amphibian eden

Stranded, or visiting, the land from water, these fish used their swim bladder to survive, a characteristic leading towards an amphibian toleration of air, and extant as the lungfish:

"There are a number of fishes that, in addition to or in place of gill breathing, have developed special organs through which they can breathe atmospheric air at the water surface. This occurs almost exclusively in freshwater fishes. In lungfishes these organs are, both in function and in structure, primitive lungs like those of amphibians. The name lungfish is thus well applied: these fishes have lungs that are derived from the swim bladder (an organ used for buoyancy in most bony fishes), which is connected to the alimentary tract. The inner surfaces of these air-breathing organs are covered with a great number of honeycomb-like cavities supplied with fine blood vessels. As in terrestrial higher vertebrates, gas exchange takes place in tiny air vesicles. Also as in terrestrial vertebrates, there is a separate pulmonary circulation."[1]

The great reward that encouraged this development was the abundant food plants on land as the Carboniferous plants flourished, only nibbled at by the contemporaneous insects.

Many species of amphibians were terminated in the great Permian Extinction that followed but many survived. Some retained their tails—such as newts and salamanders—while others went through a metamorphosis from fish-like larvae to tailless-forms such as the extant frogs and toads where the tail is absorbed and legs sprout, a change governed by thyroxine, an iodine-containing hormone, that is crucial in vertebrate development to this day. The lack of which causes problems in human development: "Thyroid hormones are critical for development of the fetal and neonatal brain, as well as for many other aspects of pregnancy and fetal growth. Hypothyroidism in either the mother or fetus frequently results in fetal disease; in humans, this includes a high incidence of mental retardation."[2]

Another innovation, was the widespread control of programmed cell death—called *apoptosis* — during development, such as the buds at the ends of the lobes which are carved by cell death into the familiar fingers and toes. "Apoptosis is a form of programmed cell death, or 'cellular suicide.' It is different from necrosis, in which cells die due to injury. Apoptosis is an orderly process in which the cell's contents are packaged into small packets of membrane for 'garbage collection' by immune cells. Apoptosis removes cells during development, eliminates potentially cancerous and virus-infected cells, and maintains balance in the body."[3]

Reptile eden

The factor that kept amphibians tied to wet-lands was that their reproduction required expanses of water, a distinct disadvantage during the Permian drought. The Logos provided a solution that was rapidly adopted: the zygote surrounded, protected and nourished by the egg:

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[1] https://www.britannica.com/animal/lungfish

[2] http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/thyroid/thyroid_preg.html

[3] https://www.khanacademy.org/science/biology/developmental-biology/apoptosis-in-development/a/apoptosis

"As happened many times, life rallied; evolution responded to ecological challenges buy appropriate adaptions. It even turned disaster into success driven, by the great Permian crises to accomplish one of the most decisive advances. While seed plants took over the cold, dry swamps left barren by the decimation of sporulating plants, some obscure amphibian suddenly soared into prominence by developing the animal equivalent of the seed: the fluid-filled egg"[1]

The normal amphibian mode of reproduction was to release multitudes of zygotes into water where at least a few would survive to form the next generation. Guided by the Logo, a female started a new lineage.

In this lineage, the zygote was enclosed "in a fluid-filled sac, the amnion, within which the embryo could pursue it's normal aquatic development…. a *milieu exterieur* to shelter the developing embryo. A hard, porous shell protected this substitute marine incubator, while a highly vascularized membrane, the allantois, produced by the embryo, and lining the inner face of the shell, served in gas exchange and waste disposal. Another sac, filled with a richly nutritious yolk, provided the embryo with the necessary foodstuffs. Thus, the complete development of the organism up to the stage where you could survive on land took place within the protective, well-stocked and appropriately renewed environment of the amniotic fluid True terrestrial reproduction was initiated. The first reptile was born"[2]

This advance proved its value during the Permian crises when reptiles advanced and radiated in a variety of forms, some of which abandoned legs, including the extant lizards, snakes and turtles—that live in the ocean but in a anti-amphibian manner return to land for breeding—but by far their greatest impact on history (and young human males) was as the sensational array of dinosaurs. These are so well-known that it is not necessary to discuss them here.

Taking Flight

Some dinosaurs took to the sky—the pterosaurs—with wingspans of 30 feet or so. It was the birds, however, that are the extant descendants of the dinosaurs who "landed on the world some 150 million years ago, as revealed by the famed *Archaeopteryx*, a fossil discovered in 1864 in a schist quarry in Bavaria. This weird animal would have passed for a small dinosaur by any test if it were not for the imprint of feathers miraculously preserved in the soft stone. Feathers, indeed, turned a reptile into a bird."[3]

This quite unexpected connection was relatively quick as it was guided by the Logos with birds as the goal. This rapid change is a puzzle to the random chance-and-accident considered dogma to many scientists:

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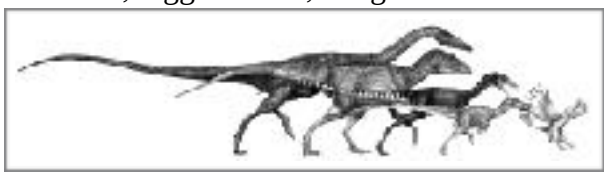
[1] Christian de Dove, Vital Dust, BasicBooks 1995, p.207

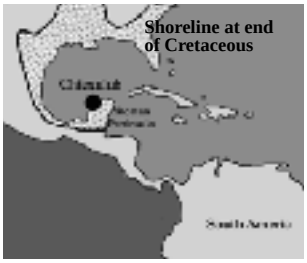
[2] ibid

[3] ibid, p. 210

"Evolutionary novelties were appearing on the bird stem lineage at a faster rate than across the rest of the tree. Many were major innovations such as complex feathers, bigger brains, wings and wishbones. Stem-birds were out-evolving their contemporaries by changing approximately four times as fast. This continual and often rapid shrinking was probably directly related to the accelerated evolution of anatomical novelties. Reduced body size, for instance, allowed bird-stem dinosaurs to explore new postures (bird-like walking where the thigh bone is held horizontal) and habitats (such as arboreal and, later, aerial habitats). This in turn would have created pressure to evolve radical new adaptations such as reshaping fluffy feathers into wings."[1]



The land-animal history, from the first amphibian appearance some 400 million years ago to the great dinosaur extinction 65 million years ago, is well-documented. In the fossil record, the dinosaurs disappeared along with the heretofore plentiful ammonite mollusks and the temporary replacement of flowering plants by ferns. This holocaust is thought to have been caused by an 6-mile-diameter asteroid hitting the Yucatan Peninsular in Mexico with an energy equivalent to 100 million megatons. The following 'nuclear winter' caused by the large amounts of sooty smoke ejected globally into the upper troposphere and lower stratosphere, reflecting sunlight and cooling the planet.



Mammalian eden

In what philosophers might call the victory of maternal tender-loving-care over might-is-right, a branch of the heretofore cold-blooded dinosaurs learned from the Logos the ability to thrive in cold climates by keeping their internal temperature at an optimal ~100°F and the faculty for gaining the extra food needed to fuel this warmth by carnivorous hunting, a thick pelt of fur and females who kept the eggs warm, then sheltered the newborns. Nourishing the young by secreting fatty liquid from their chest, this eventually developed into the mammary glands and the advent of maternal care by the mammals.

They were actually around for ~200 million years during the ascendancy of the dinosaurs, rat-like and rarely bigger than a rabbit. One lineage learnt how to hatch the eggs inside the female body. The marsupials—such as the kangaroo—delivered the very immature young and nourished them in an external pouch about the mammary glands. The final reproductive development was the placenta which allowed internal development so that the young were often essentially functional at birth—such as a foal that can walk just 15 minutes after birth—or need a period of parental care that—as in the case of humans—might last a decade.

"They acquired certain traits that would characterize mammals ever afterward: limbs positioned under the body, an enlarged brain, a more complex physiology, milk-producing glands, and a diverse array of teeth -- incisors, canines, premolars, and molars. Already present were the ancestors of the three major mammalian groups that exist today—monotremes (platypus and spiny anteater), which lay eggs externally; marsupials (kangaroos, opossums), which carry their young in a pouch; and placental

[1] http://www.iflscience.com/plants-and-animals/how-small-birds-evolved-giant-meat-eating-dinosaurs/

mammals (humans, cows, horses), which retain the fetus internally during long gestation period. In the early Cenozoic era, after the dinosaurs became extinct, the number and diversity of mammals exploded. In just 10 million years—a brief flash of time by geologic standards —about 130 genera (groups of related species) had evolved, encompassing some 4,000 species.

"These included the first fully aquatic mammals (whales) and flying mammals (bats), as well as rodents and primates. This sudden expansion of species diversity into new ways of life is known as adaptive radiation. One way it occurs is in response to events that free up previously occupied environmental zones and roles, making way for many new species that adapt to these vacant living spaces. The extinction of the dinosaurs was one such major event, eliminating a once-dominant group of competitors while some mammals survived. But the mammals did not simply step into ecological roles vacated by the dinosaurs. It took several million years for the mammals to evolve even moderately large body sizes, and the world they inherited was a different place from the one the dinosaurs had dominated. There were new environmental habitats and new food resources to exploit. By the end of the Cretaceous, flowering plants had become dominant, providing food for burgeoning populations of insects, which in turn became another high-quality food source for the mammals, along with fruits and berries."[1]

Human eden

There was a long history leading up to origin of modern humans. One of the earliest fossil of this preparation period is that of famous *Lucy*: "Australopithecus afarensis is one of the longest-lived and best-known early human species—paleoanthropologists have uncovered remains from more than 300 individuals! Found between 3.85 and 2.95 million years ago in Eastern Africa (Ethiopia, Kenya, Tanzania), this species survived for more than 900,000 years, which is over four times as long as our own species has been around. It is best known from the sites of Hadar, Ethiopia …'Lucy'… and the 'First Family'…; and Laetoli fossils of this species plus the oldest documented bipedal footprint trails"[2]

The dating of the fossil records found in Africa reveals the timing—in millions of years ago (mya)—of the steps towards our fully-functioning upright posture that the the pre-human lineage learnt from the Logos:[3] Ability to walk upright (6 mya); Strong knees (4.1 mya); Curved spine (2.5 mya); Hip support (2 mya); Fully bipedal (1.9 mya).

About the time a lineage became fully bipedal, history entered the Old Stone Age, the Paleolithic Period: "[Pre] humans in East Africa used hammer-stones to strike stone cores and produce sharp flakes. For more than 2 million years, early humans used these tools to cut, pound, crush, and access new foods —including meat from large animals."[4]

It was thought that pre-humans only mastered fire only towards the end of the Paleolithic but discoveries in 2012 suggest it happened about half-way into this period: "Now, however, an international team of archaeologists has unearthed what appear to be traces of campfires that flickered 1 million years

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[1] https://www.pbs.org/wgbh/evolution/library/03/1/l_031_01.html

[2] http://humanorigins.si.edu/evidence/human-fossils/species/australopithecus-afarensis

[3] http://humanorigins.si.edu/human-characteristics/walking-upright

[4] http://humanorigins.si.edu/human-characteristics/tools-food

ago. Consisting of charred animal bones and ashed plant remains, the evidence hails from South Africa's Wonderwerk Cave, a site of [pre-human] habitation for 2 million years."[1]

Stone tools and fire were the main advances during the 2 million years of the Paleolithic. About 100,000 years ago, this stasis ended and we entered a time of rapid development: the New Stone Age (Neolithic), advent of agriculture, the first cities, pottery, the Bronze Age, writing, the Iron Age, etc. This period of rapid change was initiated by the Origin of Humans.

All three of the traditional Abrahamic faiths—Judaism, Christianity and Islam—state that the first man and woman were created in the Garden of Eden, as does the newcomer, Unificationism. The debate over where this Eden might be has ranged from the Middle East, the Far East, even Tasmania. But the scientific consensus, based on a variety of evidences, is that the first humans first appeared in Africa. This is the "Out of Africa" perspective that is supported by genetic evidence, fossil evidence, and less strongly by linguistic evidence.

Research into the global variation of mitochondrial DNA—passed down solely through the maternal line—and Y-chromosome DNA—passed down solely through the paternal line—has established the existence of a "Mitochondrial Eve" and a "Y-chromosome Adam" living in Africa tens-of-thousands of years ago:

"The Book of Genesis puts Adam and Eve together in the Garden of Eden, but geneticists' version of the duo — the ancestors to whom the Y chromosomes and mitochondrial DNA of today's humans can be traced — were thought to have lived tens of thousands of years apart. Now, two major studies of modern humans' Y chromosomes suggest that 'Y-chromosome Adam' and 'mitochondrial Eve' may have lived around the same time after all….The finding provided evidence for the theory that modern humans evolved in Africa before migrating to other continents."[2] The caveat being that they are not necessarily the first humans as a maternal lineage ends in a family with all sons, and a paternal with all daughters.

Support for the Out-of-Africa scenario also comes from the study of 6,000 skulls from more than a hundred ancient human populations:

"Scientists who compared the skulls and DNA of human remains from around the world say their results point to modern humans (Homo sapiens) having a single origin in Africa. The study didn't find any evidence to suggest that human species living elsewhere in the world contributed to our direct ancestors' make-up. … The team found that loss of genetic diversity was very closely mirrored by reduced physical variation the farther away people lived from Africa.The new data support the single origin, or 'out of Africa' theory for anatomically modern humans, which says that these early humans colonized the planet after spreading out of the continent some 50,000 years ago."[3]

A similar conclusion came from the study of the world's languages and how they have diverged over time: "[Quentin D. Atkinson], a researcher analyzing the

[1] http://www.history.com/news/human-ancestors-tamed-fire-earlier-than-thought

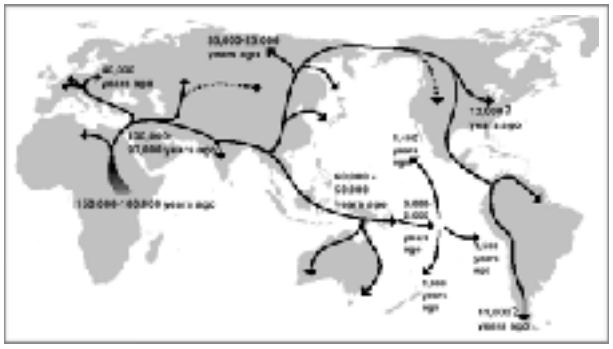
[2] http://www.nature.com/news/genetic-adam-and-eve-did-not-live-too-far-apart-in-time-1.13478

[3] http://news.nationalgeographic.com/news/2007/07/070718-african-origin.html

sounds in languages spoken around the world has detected an ancient signal that points to southern Africa as the place where modern human language originated. The finding fits well with the evidence from fossil skulls and DNA that modern humans originated in Africa. It also implies, though does not prove, that modern language originated only once, an issue of considerable controversy among linguists."[1] All this prompted a major magazine in the USA to feature the topic on its cover.[2]

The first humans were born into a population of pre-humans, who nursed them, raised them and protected them from wild animal. I have discussed this in detail in a previous book.[3] The birth of the first humans was the culmination and full expression, needing only the fulfillment of human responsibility—essential if free and true love, rather than programmed love—was to flourish.[4]

This aspect was not accomplished. In scientific terms—rather than theological—the Fall of Man involved the statutory rape of a minor and the eventual formation of a spiritually-dysfunctional family where the first fratricidal murder occurred. This spiritual dysfunction was passed on to all succeeding generations—the Original Sin of theology—while the principles of the Logos were applied in the history of salvation.[5]



From Africa, humans migrated to all the continents, as mapped by genetic markers. "The evidence that helped prove the theory about human migration out of Africa included DNA sequencing, this included Mitochondrial DNA analysis, Y Chromosome analysis and Micro-satellite DNA analysis. Other evidence of human migration out of Africa were fossil recordings. Genetic evidence has been used to prove some theories of human migration out of Africa."[6]

Humans, without a health spirit, became as animals: "No arts; no letters; no society; and which is worst of all, continual fear, and danger of violent death: and the life of man, solitary, poor, nasty, brutish and short."[7]

So great was this original degradation more than 100,000 years ago, that it was only ~6,000 years ago that a great advance was made with the advent, by inspiration, of laws—such as *do not murder*—and started a course of improvement that continues to this day.

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[1] http://www.nytimes.com/2011/04/15/science/15language.html?mcubz=0

[2] *Newsweek*, January 11, 1988

[3] Richard L. Lewis, *The Unity of the Sciences in Unification Thought, Vol. 3: Life, Mind and Spirit,* UTI Tokyo, 2013 pp. 147-158

[4] *Divine Principle* Principle of Creation

[5] *ibid* Fall of Man, History of Restoration.

[6] http://madisonhistory2014x.weebly.com/question-2.html

[7] Thomas Hobbes, *Leviathan*, 1651

Free Will

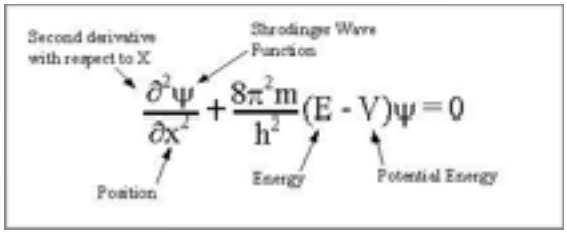
The concept of humans having free will has been contentious in both religion and science.

In religion, there is a belief that God is in total control, and that everything that happens is according to God's Will. Humans are incapable of doing anything God does not want. The phrases "God willing" and "it's God's will" express this view. Somewhat contradicting this, the phrase "Satan made me do it" is not uncommon while "God made me do it" is. A God that is omnipotent in a world in which evil is ingrained leads to the concept that God is both good and evil. Unification Thought embraces the concept that humans are God's children, and have a creative ability just like their parent. Responsibility for fulfilling the purpose of creation is therefore mutual and divided, symbolically as 95% God's, 5% human's. God inevitably fulfills his portion, it is the human portion that has remained historically unfilled.

In science, *classical* physics has great difficulty with the concept of free will. If natural law rules fundamental particles, and all molecules are made of them, and if the brain is just a chemical machine generating flows of electrons, then the brain function is ruled by natural law, then: ''The brain secretes thought, as the kidneys secrete urine, or as the liver secretes bile."[1]

Quantum physics (QP), whose concepts are alien to most laymen and even some scientists, does not suffer this problem. Akin to Unification Thought, QP states that all fundamental particles (and hence all things made of them) have an abstract (internal) aspect describable only with imaginary, complex numbers (the wavefunction) that projects into the external realm as a real probability that governs the behavior, interactions and future history of the fundamental particle. In QP natural law absolutely determines the internal aspect and its changes, the projected probability governs the external behavior.

Unlike classical physics, in QP the law indirectly governs the external reality. Something as simple as an electron has what could be called an inherent freedom to choose, for in a situation of binary choice where the wavefunction determines either has a 50% probability, that it is impossible in principle, even for God[2], to know which path will be chosen by the electron.



The natural law that governs the electron's wavefunction in an atom, the complex number **Ψ**, is succinctly expressed by Schrodinger's equation: "The solution to this equation is a wave that describes the quantum aspects of a system. However, physically interpreting the wave is one of the main philosophical problems of quantum mechanics."[3] The associated probability is simply its absolute square, the real number $|\mathbf{\Psi}|^2$.

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[1] James, William *The Principles of Psychology* (1842-1910)

[2] The definition of random.

[3] http://www.physlink.com/education/askexperts/ae329.cfm

Luckily, one does not have to be a mathematical virtuoso to experience the internal wavefunction at work. There are two simple ways, one external, the other internal.

Externally, you experience the wavefunction each time you see a reflection in a pane of glass. This phenomenon was a great puzzle to Newton, the founder of classical physics, who viewed light as particles, nowadays called photons: why do most fly right through while a few are reflected back. What is the difference between them? Why does reflection depend on the thickness of the glass. Newton could not come up with a reasonable answer. QP can explain all this by the wavefunction and the probability of a reflected photon. This, and more, is fully discussed by Richard Feynman in his highly-recommended book, *QED: The Strange Theory of Light and Matter.*

Internally, we experience the influence of the Logos on our internal aspect, our mind, as the conscience. This lets us know what is good, but we do not necessarily follow it. The Logos suggests but does not compel.

PTOLEMY WAS RIGHT, ALMOST

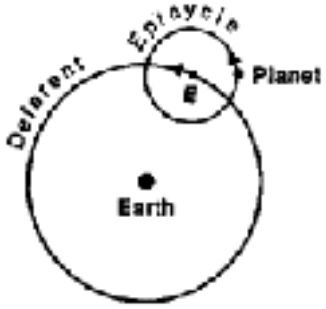
Unification Thought maintains that the Logos was designed by God to create a Universe for humankind. Humans were to be the center and purpose of the entire vast expanse that the Logos would create over time.

Claudius Ptolemy lived in Alexandria almost nineteen hundred years ago and was a famous writer, renown as a mathematician, astronomer, geographer and astrologer. He was perhaps the first to attempt a scientific explanation of the universe in which we find ourselves. He also sensed that humankind was at the center of things (which is correct) and that the earth was at the center of the solar system (which was incorrect). His greatest, and long-lasting theory was his Earth-Centered model of the universe—now known as the Ptolemaic system.

This theoretical construct started with what seemed the most obvious of observations: That the Earth was at the center of the universe and everything else revolved in circles around the Earth.

Earth, he argued, is a stationary sphere at the centre of a vastly larger celestial sphere containing the fixed stars that revolved at a perfectly uniform rate—once a day—around the Earth. The other heavenly bodies—the planets, Sun and Moon—had their own spheres that rotated at different rates.

In order to account for the rather irregular motions of the planets—some, like Mars, occasionally went backwards—he had to complicate this simplicity by adding epicycles—smaller local circles—to make his theory reflect reality —an absolute requirement for any scientific theory, no matter how elegant.



So successful was this geocentric theory that his book—now known as the Almagest—was considered textbook-truth for more than fourteen hundred years. This status-quo lasted until the era of the Renaissance when much was reconsidered.

Since then, Ptolemy's ideas of perfect circles with the Earth at the very center has been consigned to the dustbin of science history, perhaps, as we will discuss, a little unfairly as he was partially correct, just got the scale of things wrong..

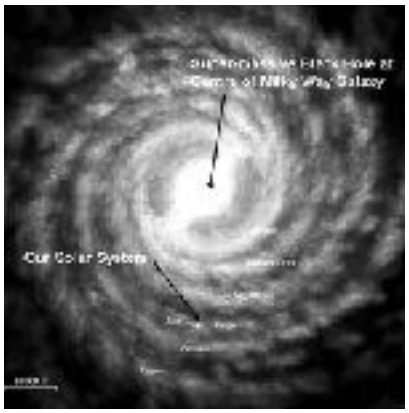
Nicolaus Copernicus was a Renaissance mathematician and astronomer who formulated a model of the universe that placed the Sun, rather than the Earth at the center of the universe. The publication of this model in his book On the Revolutions of the Celestial Spheres just before his death in 1543 was a major event in the history of science, triggering the Copernican Revolution.

His heliocentric view put the Sun at the center of the solar system, then orbiting around it the four inner rocky planets—including the Earth. Between Mars and Jupiter the rocky asteroid belt, then the

four gas-giant planets and finally the Kuiper Belt, a halo of rock-and-ice proto-comets and planetoids with Pluto being the largest. Much of this outer structure was added later, and eclipses replaced perfect circles, but the basic model remained unaltered.

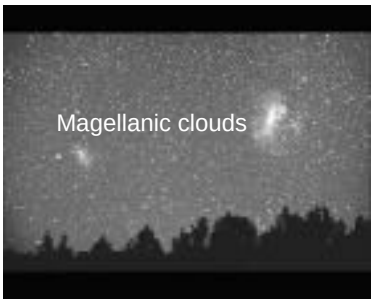
The belt's outer edge is about 50 times further from the Sun than the Earth (93 million miles) and can be considered the boundary of the solar system.

In America with its 55mph speed limit, distance is ofter measured by the time it takes to drive there. A friend who lives 2 hours away is 110 miles away. In a similar way, astronomy uses the universal speed-of-light limit to measure distances. The radius of the solar system is ~7 light-hours. The Earth is definitely not at the center.

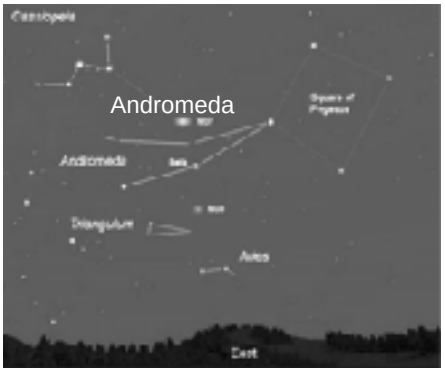


With the invention of the telescope, it turned out that the Milky Way, that mysterious cloud amidst the fixed stars, was actually composed of myriads of stars too far away to be discerned.

The center of our spiral galaxy—located in the Sagittarius sector of our sky—is about 26,000 light-years away and contains a supermassive Black Hole. Around this center, all 100 billion stars in our home galaxy orbit every 250 million years or so with our solar system far from the densely populated core.



For a while, the galaxy was considered all there was, a universe of 100 billion stars, of which our Sun was just one. The radius of our galaxy is ~100,000 light-years, and neither the solar system nor the Earth is at the center.



The only hint that there was more to the universe were objects that were not sharp points to eye or telescope like regular stars are, but were fuzzy like clouds among the stars. Only a few are visible to the naked eye; small Andromeda in the Northern sky and the impressive Magellanic clouds in the Southern sky. Millions more were visible with a good telescope.

A debate as to whether these clouds were inside or outside our galaxy raged for decades until a definitive answer was provided by observing the explosive deaths of giant stars; supernova that briefly outshine all the other 100 billion stars in the galaxy. The answer was clear: Andromeda and the Magellan's were well outside our galaxy, not inside it. To be visible at all at extragalactic distances, they had to be very large indeed.

The Magellanics turned out to be local mini-galaxies just 58,000 light-years distant, slowly orbiting our galaxy. Andromeda, however, revealed itself to be a galaxy very similar to our own. Similar size, 100 billion stars; similar form, a spiral rotating around a supermassive Black Hole; similar in status, it has its own orbiting set of mini-galaxies. This sister galaxy is 4 million light-years distant, but not too far for gravity which is pulling Andromeda and the Milky Way together at a speed of 250,000 miles per hour. This is not a cause for concern yet; we have about five billion years before the encounter.

To be sure, some of the fuzzy objects revealed by telescopes were found to be massive clouds of tenuous gas in our own back yard; but millions, then billions of them were found to be independent galaxies, at increasingly immense distances.

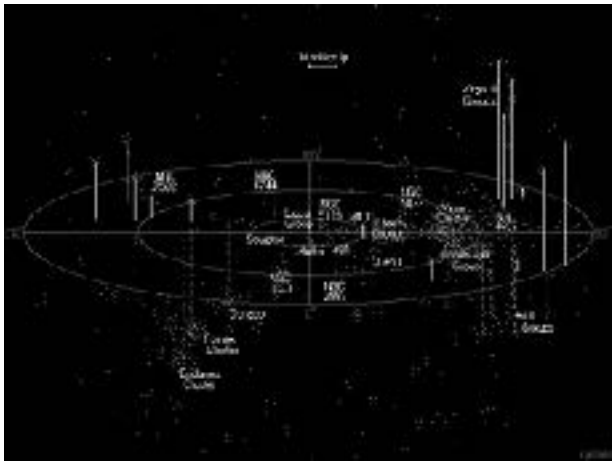
The Milky Way and Andromeda are the two dominant members—in a gravitational sense—of a dozen or so small galaxies called the Local Group.

This local assemblage is, in turn, a member of the Virgo cluster of about 2,000 galaxies in a volume of space about 20 million lightyears across. The Earth can in no way be considered to be at the center of the Local Group or the Virgo Cluster.

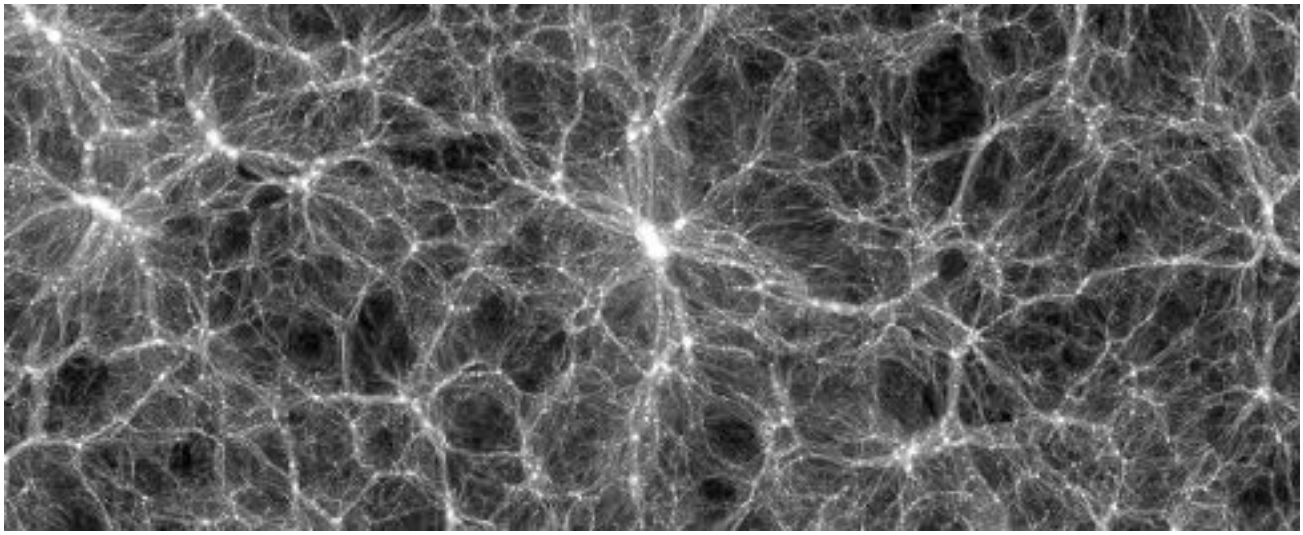
Such clusters containing thousands of galaxies are, in turn grouped into superclusters of millions of galaxies. The Virgo Supercluster or Local Supercluster is a mass concentration of galaxies that contains dozens of clusters including the Virgo Cluster which embraces the Local Group, which in turn contains the Milky Way and Andromeda Galaxies. This rather flat supercluster extends over 110 million light-years. The Earth can in no way be considered to be at the center of the Virgo Supercluster.

Superclusters, in turn, are connected together into a mesh that crisscrosses the universe with strands composed of superclusters of galaxies.

This is a simulation of the Great Wall, a web of superclusters connected by gases extending over about 5 billion lightyears. Thanks to gravity—mainly due to the mysterious dark matter that is five-times more abundant than regular matter—these superclusters stay connected and swirl together through the void of space.



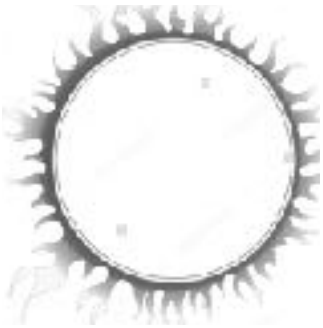
On a daily level, the speed of light is all but instantaneous. Communicating with the astronauts on the Moon by radio waves—a variety of light—introduced a noticeable lag when chatting. On a cosmic scale, the speed of light is slow, akin to flowing molasses in Antartica. When we see a galaxy that is a



billion lightyears away, we are actually seeing the galaxy as it was a billion years ago.

It is now well established that the Universe had its origin about 13 billion years ago in the fiery Big Bang. For the first 400 thousand years or so of its existence the entire universe was hotter than our Sun is today. As anyone knows who has attempted to see beneath the Sun's surface, the plasma of which it is composed is utterly opaque to the passage of light.

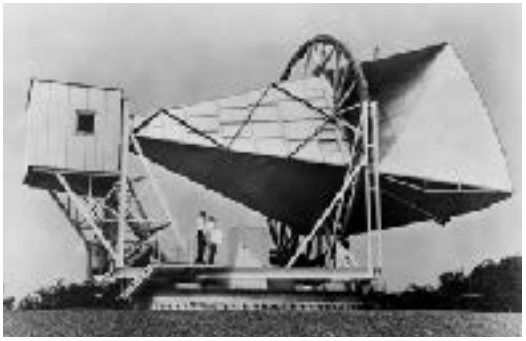
After this fiery period, however, the expanding universe had cooled enough for the plasma to combine into atoms for the very first time (a misnomered period called recombination) and the universe became transparent and light could travel freely.



For this reason, the very furthest we can see is the fiery surface of the recombinant universe as it was about 13 billion years ago. This incandescent surface is the very boundary of the visible universe, a perfect sphere that surrounds us like the skin of an immense balloon.

The reason why the night sky is not incandescent like the Sun's 9,900° surface is that light has energy, and the universe has been expanding for 13 billion years. Just like matter, the energy of light has been gravitationally resisting this expansion, and this effort has slowly sapped the energy from the light of creation. Nowadays, the light of the boundary has cooled to microwaves, just a tad above Absolute Zero, a chilly –460°.

If our eyes could respond to microwaves, we could see this boundary wall of the visible universe surrounding us on every side.



Advances in technology have resulted in detectors capable of 'seeing' these microwaves. The first, and most primitive, was built in a New Jersey field and run by Penzias and Wilson who were the first to 'see' the boundary to the visible universe.

At the resolution of these first detectors, the fiery boundary looked remarkable uniform in every direction. Later, when more sophisticated detectors were lifted above the Earth's atmosphere by rocket, slight variations of one-in-ten-thousand were discovered in this Cosmic Microwave Background, speckles which are currently a subject of intense scrutiny.

The current picture of the boundary to the universe (a 3D object adapted for 2D display) is a speckled surface of slightly warmer, slightly cooler pixels. The sphere that is the Visible Universe has a diameter of ~26 billion lightyears. Most scientists would agree that the Universe is a lot larger than this, but the rest is quite invisible and undetectable as nothing travels faster than light does.

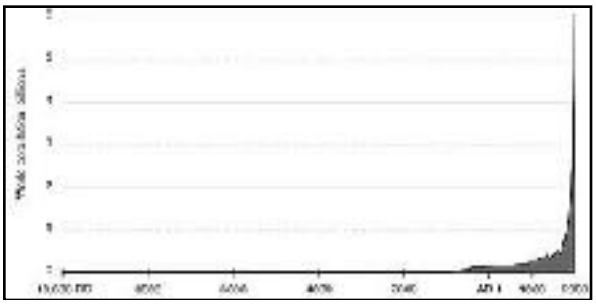
On this scale of ~26 billion lightyears, the movement of the Earth about the Sun—about 16 light minutes—is infinitesimal, and the Earth is at the center of this vast sphere.

So we can, at last, conclude that Ptolemy was correct; that except for scale, the Earth is at the very center of the perfect sphere that is Observable Universe. He just had no concept of how vast it was.

It is humans, however, that are the important factors, not the planet, and wherever we go—even to a galaxy far far away—when we look (with the appropriate instruments) we will see ourself at the very center of a perfect sphere of fire. Humans will always live at the very center of God’s universe.

DUAL CHARACTERISTICS AND INTERSTELLAR TRAVEL

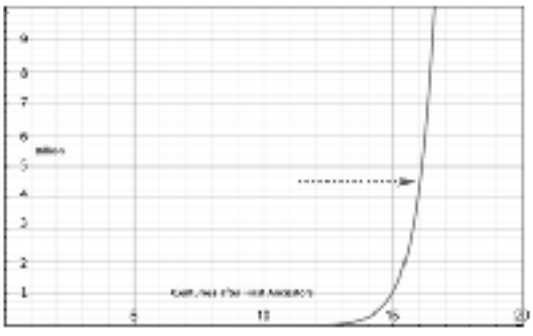
The necessity for a method for the human race to spread out to the stars and galaxies is driven by the mathematical properties of geometric growth. Anthropology suggests that the human First Ancestors appeared in the midst of a prehuman population ~80,000 years ago marked by the transition from the Paleolithic Age—with cycles of innovation taking millions of years—to the Neolithic Age with cycles of change taking just centuries, even decades. Genetic studies also place humanity's origin in the same time period with the studies of Mitochondrial Eve and Y-chromosome Adam, followed by the Out of Africa migration to populate eventually all land areas of the globe. (This perspective is examined in more detail in my book on science and Unification Thought.1)



Population growth, however, was not geometric over the succeeding 80,000 years of Fallen history inasmuch as disease, war and famine kept the surviving human population small for most of Fallen history. The graph[2] on the right gives an estimate of human population growth showing that, for most of Fallen history the population was small. It is only in the last few centuries that the population has grown dramatically, passing the six billion mark as we entered the third millennium—an intimation of the power of geometric growth.

The *Divine Principle*, however, is most emphatic in stating that the Fall of the First Ancestors was not a part of the Original Plan. The Creator intended a humanity expressing True Love to emerge and the restraints of war, disease or famine on population growth to never emerge.

In the intended history, it is a reasonable assumption that the human population would double every 50 years (every 25 years if the average family size was 3 sons and 3 daughters). The mathematical formula giving the global population, P that would emerge N centuries after the advent of Adam and Eve is simple: $P = 2^{2N}$



The graph to the right of this equation shows that the current population of 6 billion could have been attained just 1,600 years after the First Ancestors. In our time, 80,000 years after the start, the population would be: 10^{480} an enormous number of people, far beyond what any conceivable technology might enable the Earth to sustain with its surface area of only 5 x 10^{18} square centimeters.

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[1] Lewis, Richard L. *The Unity of Science in Unification Thought.* New York, NY: UTI-USA, 2009 pp. 507-521

[2] Katja Keuchenius *False Numbers: Muslims And Population Growth* http://www.united-academics.org/magazine/getting-right/muslim-global-population/ 2013

This problem was first publicized in 1798 by Thomas Malthus who pessimistically wrote:

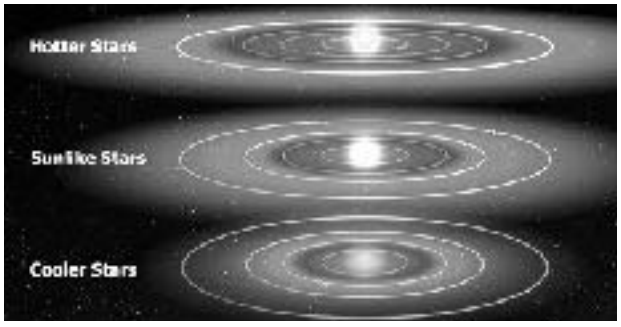
Famine seems to be the last, the most dreadful resource of nature. The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race.[1]

Clearly, the Original Plan was either to invoke drastic birth control measures or to provide for expansion on a plethora of planets other than the Earth. As the first alternative is anathema to the spirit of the *Divine Principle* view of the Creator, we can expect provision was made for the second alternative —expansion to other planets. This view, unlike that of Malthus, is decidedly optimistic.

Many Earths

Fortunately for this perspective, modern astronomy has determined that there are plenty of Sun-like stars in the observable universe. Roughly 50% of the 100 billion stars in our Home Galaxy are suitable hosts for inhabitable planets—the O- and B- and A-type stars being too large and hot, while the M-type stars are too small and cool to be suitable—in the Habitable Zone about the star where water exists as gas, liquid and solid. In our galaxy, there are thus 50 billion stars that are possible suitable hosts to life-bearing planets.

In our solar system, the Earth is smack in the center of the zone and temperatures are just right. Mars is outside the outer boundary of the zone and too cold with carbon dioxide a solid, while Venus is outside the inner boundary and too hot with lead a liquid. Our yellow Sun is classified as a G-type star. Slightly larger, hotter blue F-type stars, and slightly smaller, cooler red K-type stars also have more or less respectively expanded habitable zones about them.



The red region [in the diagram] is too warm, the blue region too cool, and the green region is just right for liquid water. Because it can be described in this way, sometimes it is also referred to as the "Goldilocks Zone".[2]

It is estimated that the observable universe contains at least another 100 billion galaxies like ours, each of which has its own abundance of amiable stars and Goldilocks Zones.

While the earliest theories of planet formation suggested that planets would be rare about stars, current theories imply that they are commonplace. This view is corroborated by the recent detection of Jupiter-like exoplanets orbiting dozens of the nearest stars:

Exoplanets have become one of the most exciting and important topics in astronomy today. In addition to finding over 5,000 new worlds, scientists using tools like NASA's Kepler mission have found that not

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[1] Malthus T.R. (1798) *An essay on the principle of population.* Chapter VII, p. 61

[2] *The Habitable Zone* https://www.e-education.psu.edu/astro801/content/l12_p4.html

> only are exoplanets as plentiful as stars in our galaxy, but that a sizable portion of them are small, rocky planets like Earth. It's possible that, only a few years from now, astronomers will be able to find a habitable planet like our own orbiting another star.[1]

Just as this section was being finalized on July 23, 2015, NASA made the announcement of the first earth-like planet to be discovered:

> NASA's Kepler mission has confirmed the first near-Earth-size planet in the "habitable zone" around a sun-like star. This discovery and the introduction of 11 other new small habitable zone candidate planets mark another milestone in the journey to finding another "Earth." [2]

It has been firmly established that simple life appeared on the Earth at the very beginnings of its 4.5-billion-year history—simple bacteria emerging about 4 billion years ago. As one Nobel Laureate affirms, this rapidity logically implies that life is a very probable occurrence:

> What this ... implies with respect to the assembly of the first cell is that most of the steps involved must have had a very high likelihood of taking place under the prevailing conditions.... In other words... the universe was—and presumably still is—pregnant with life.[3]

While intelligent life, and even trees and rats, took much, much longer to get established, this simple life rapidly transformed the atmosphere of Earth from its original poisonous anoxia into one of bountiful oxygen and inert nitrogen as early as 3.5 billion years ago. We can conclude from both science and theology that we would expect to find that there are plenty of habitable Earth-like planets in the habitable zone with an oxygen atmosphere scattered throughout the universe. One early estimate of planets with liquid water and an oxygen atmosphere calculated that our galaxy might contain 600 million such benevolent planets4 ripe for human migration.

Encountering non-Earth life, even bacteria, will have a profound impact on biological thinking. Current thought, based on the atheism that dominates modern science, is that life was accidental and that the biochemistry underlying life's functioning could have been radically different. The origin and evolution of living systems was utterly contingent and, as evolutionist S. J. Gould famously asserted in a thought experiment, would be entirely different if the development of living systems was repeated over from the start:

> I call this experiment "replaying life's tape." You press the rewind button and, making sure you thoroughly erase everything that actually happened, go back to any time and place in the past . . . . Then let the tape run again and see if the repetition looks at all like the original.… any replay of the tape would lead evolution down a pathway radically different from the road actually taken.[5]

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[1] *20 YEARS OF EXOPLANETS* http://planetquest.jpl.nasa.gov/page/20-years

[2] http://www.nasa.gov/press-release/nasa-kepler-mission-discovers-bigger-older-cousin-to-earth

[3] de Duve, Christian, Vital Dust: Life as a Cosmic Imperative. New York: Basic Books, 1995. p.9

[4] Asimov, Isaac, *Extraterrestrial Civilizations*, New York: Crown Publishers, p.169

[5] S. J. Gould, *Wonderful Life: The Burgess Shale and the Nature of History,* New York: Norton, 1989, p. 48-51

The theistic view, as exemplified in the Divine Principle, takes the opposite point of view. The structure and functioning of living things was charted out in the Original Plan. We can expect life on an exoplanet to take a very similar path to that on Earth. We can expect, for example, that life will involve L-amino acids in proteins—the masters of analog manipulation—and D-nucleotides in DNA/RNA—the masters of digital manipulations. We do not expect to find life using D-amino acids or L-nucleotides which are toxic to our kind of life.

Such a showdown between a contingent view and a created view of biological evolution is a long way off, but astronomers have already found planets that could harbor simple life:

> What about Earth-like planets with Earth-like orbits? Of the 461 new planet candidates, 51 of them are in the so-called "habitable zone," the Goldilocks region around the star that's at just the right temperature for liquid water to exist. And one of these new planet candidates has all three of the qualities we're looking for in a twin Earth: it's in the habitable zone, it's only 1.5 times the size of Earth, and it's orbiting a sun-like main sequence star.[1]

Finding such planets with a telescope is relatively easy. The real challenge is getting there from Earth so that we can explore, and hopefully populate, those exoplanets.

The Classical Challenge

Classical physics affirms the commonsense view that in order to get from point A to point B you need to traverse all the points that lie between them.

The first problem is that even the nearest stars are very, very distant. Alpha Centauri is considered a nearby star but is 40 trillion kilometers away. It takes speedy light more than 4 years to get there from here—traversing a distance of 4.4 light years—while the Home Galaxy is 100,000 light years across and the nearest galaxy, Andromeda, is 4,000,000 light years distant.

Current technology is only capable of attaining speeds much less than the speed of light, and theory suggests that velocities greater than 10% light's speed (~70 million mph) would be fatal since interstellar gas would, at such speeds, be encountered as lethal, high-energy cosmic rays almost impossible to shield against. Forty years' travel to the nearest star is not an inducement to human migration. The centuries it would take to reach the majority of stars in our galaxy would entail a multigenerational journey—providing great scenarios for science fiction writers but not a convenient way of relieving population pressure on Earth. For example, the recently discovered Earth-2 is 1,500 lightyears distant. At 1/10th light speed, it would take 15,000 years to get there!

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[1] Moyer, Michael, *Earth-Like Planets Fill the Galaxy, 2013*
http://blogs.scientificamerican.com/observations/2013/01/08/earth-like-planets-fill-the-galaxy/

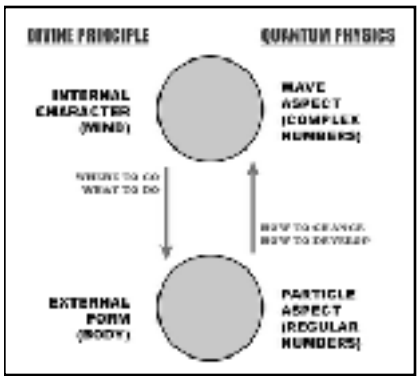
The second major problem is that outer space is utterly hostile to life—no air, no water, no food, no atmospheric shielding of cosmic rays, so hostile that even simple errors can lead to rapid death. A detailed compilation of the hazards encountered in space travel has been published by Dr. Comins.[1]

For these reasons we conclude that the Creator must have had a quite different method of travel in mind for His ever-expanding family. For clues to what this might be, we look to the confluence of theology and science in the *Divine Principle* and quantum physics.

Dual Characteristics

The *Principle of Creation* states that all things are created with two unified sets of dual characteristics. The primary duality is the vertical unity of internal character (mind) and external form (body). The secondary duality is the horizontal interaction between male and female animals and plants, electropositive and electronegative chemical elements, and plus and minus electric charge.

Quantum physics affirms the same basic principle, albeit using different terms and mathematical precision. The fundamental entities which interact to form atoms, molecules, cells and all things have a dual nature. They have an internal **wave** aspect which is mathematically described by complex numbers (with both a linear size and a circular rotation), and an external **particle** aspect which is mathematically described by regular numbers (with linear size only).



The mathematical connection between the two types of numbers is simple: the absolute square of the internal complex number generates the external real number which gives the probability of what the external particle will be and do in space and time. In classical physics, the probability of a event is calculated by adding up the probability for all the different ways in which the event can occur. In quantum physics, it is the *probability amplitudes*—the name given the complex number—that must be added, then squared to give the final, real probability. It is the great difference between adding *real* numbers and adding *complex* numbers that is the source of most of the "weirdness" that classical physicists attribute to quantum science.

Even at the most basic levels of the physical world, such as in the behavior of electrons and photons, however, the particle has the ability to freely choose its future within the bounds of the probability. So, if the internally-generated probability is 0% or 100%, there is no freedom of choice; if the probability is divided 50-50 between two paths, there is no way to predict which of the two paths will be taken—the choice is totally random and unpredictable.

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[1] Comins, N.F. 2007, *The Hazards of Space Travel*, New York: Villard Books.

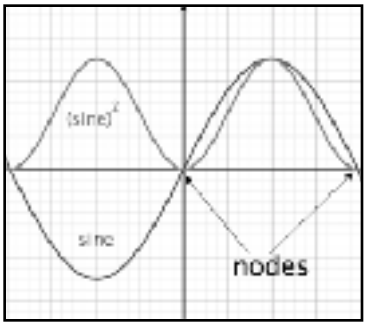
The internal wave is non-local and spread out in spacetime while the external particle is localized at a local position in spacetime. Heisenberg's Uncertainty Principle prevents this from being a at a point—with zero extension—so it jitters about, but with high-energy probes the electron has been located to within a billion billionth of a meter, 10^{-18}m, which is a tiny locality even on an atomic scale.

The internal and external aspects, as expected from the *Divine Principle* perspective, are unified and reciprocally related to each other. Quantum physics states that:

a. The internal wave determines the probability of where the external particle will be in spacetime and what it will do there.

b. The external interactions of the particle determine how the internal wave will change and develop in space and time. (These concepts are explored more fully in my book addressing science in Unification Thought.[1])

Both disciplines agree that the internal wave aspect is subjective, while the external particle aspect is responsive. This is the source of much confusion to scientists with a classical perspective since the external particle always does what the internal wave tells it to do, even if the instruction is to do something quite impossible in classical physics (which is, of course, ignorant of the internal aspect to reality).



One of the most classically-impossible behaviors involves the *nodes* of waves, i.e., places where the wave is zero and where the particle can never be.

Wave Nodes

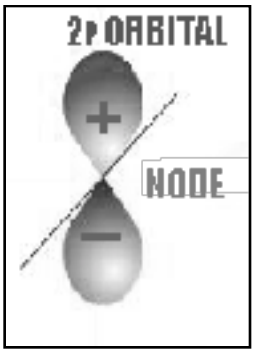
Any wave, such as a sine wave, has an amplitude (shown in blue in the above diagram) that goes from positive to negative and back again. The square of the amplitude is the intensity of the wave (shown in red) and is always positive. For the internal wave aspect in quantum physics, it is this intensity that generates the always-positive probability that directs the behavior of the external particle.

Where the internal amplitude crosses zero from positive to negative or vice versa, the external probability is exactly zero—it is impossible for the particle to be at that location.

It is such nodes that lead to what classical scientists call "quantum weirdness." For example, the standing electron waves that occur in the atom can have two lobes, such as in the 2p orbital, that are separated by a node at the atomic nucleus. The electron particle spends 50% of the time in one lobe and 50% in the other, but spends zero time at the node that separates them. In the vernacular, we would say it

[1] Lewis, Richard L. (2013) *The Unity of Science in Unification Thought* (New York: UTI-USA) pp 210-260

teleports between the two lobes, ignoring the space that separates them, while the technical term is *tunneling* between the two lobes.



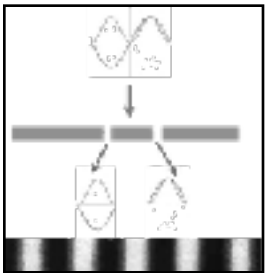
Such behavior is utterly nonsensical in classical physics—where the negative electron would sit on the positive nucleus, not avoid it completely—but makes sense in quantum physics where the wave determines what the particle will do.

The atomic node here only spans a few nanometers, but even stranger behavior occurs when the node stretches over a considerable spatial separation, as it does in the slit experiment which played such a leading role in the revolution from classical to modern physics.

Slit Experiment

In a suitably-designed apparatus, the wave aspect can be can be split into two and the node that separates the two nodes can cover many centimeters. This is demonstrated by the simple slit experiment where the wave is separated into two lobes that pass separately through two slits in a barrier. On the far side, the two waves interfere with each other creating fringes of high probability and low probability—and this occurs when a single particle at a time passes through the apparatus.

To the classical mind, it appears that the single particle passes through both slits at the same time. This is not so. Rather, the particle spends 50% of the time passing through one slit, and 50% in the other, tunneling rapidly from one location to the other. Attempts to detect which slit the particle is traveling through inevitably involve an interaction, and this inevitably alters the internal wave and changes the result.



Such slit experiments dividing the internal wave have been performed on simple things—such as electrons, photons and single atoms—as well as complex molecules such as fullerenes with sixty or more atoms in their spherical structure. This molecule is definitely ‘matter’ exhibiting the reality of its internal wave aspect. It is probably only a matter of time until some brilliant experimenter manipulates the internal wave of a bacterium and gets its external body to seemingly pass ‘through both slits at the same time.’

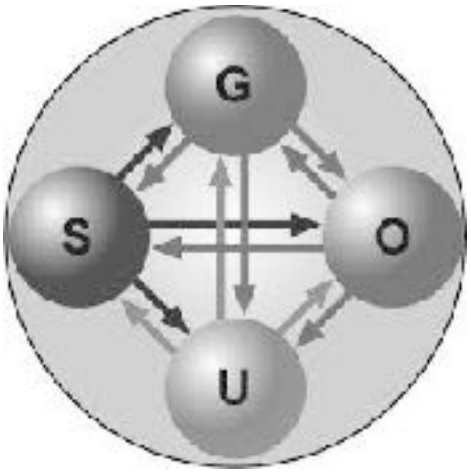
External Form and Internal Character

The external form and internal character of an electron mentioned above can be applied to atoms and molecules. An atom is composed of electron(s) and a nucleus, and there exists interaction between them. Atomic mass corresponds to the external form and the atomic wave function, consisting of nuclear and electronic wave functions, corresponds to internal character.

In the same way, a molecule is composed of electrons and many nuclei, and there exists interaction between them. Molecular mass corresponds to the external form and the molecular wave function,

consisting of combined atomic wave functions, corresponds to internal character. While an electron has only a negative charge, an atom or a molecule have net zero charge as a result of having equal amount of positive charges and negative charges in the nuclei and in the electrons, respectively. Between the nuclei and the electrons, it is the electrons that determine chemical properties, participate in the chemical reactions, and behave by quantum dynamics. The Born-Oppenheimer approximation in quantum mechanics treats nuclei practically stationary with respect to the electrons.

Also, it is of note that distortions in the orbitals caused by external interaction are often accompanied by changes in the molecular structure, i.e., the positions of the nuclei. This change in structure is particularly important in protein activity where interaction with, for example, a calcium ion can radically alter the protein's folded structure and activity—a conformation change. Clearly, the electrons play central roles in both an atom and a molecule.



At this point it is worthwhile mentioning that the discussion on an atom and a molecule above can be described by the Four-Position Base in *Unification Thought*, diagrammed on the right.[1] Basically, the Four-Position Base describes the Give-and-Receive relationship between the Subject and the Object based on four positions consisting of the God, the Creator; the interacting Subject and Object and the Union created as a result. Accordingly, the electrons as the Subject and the nuclei as the Object in Give-and-Receive-Action with Heart as the Center and the result is an atom.

Currently about 116 elements are known, and among them 88 elements occur naturally. We may say that 88 elements, i.e., 88 atoms were formed as described above. The other 28 elements were made in the laboratories by the scientists, and these scientists appear to create atoms at the level of the Creator. However, the manmade atoms are found unstable and short-lived compared to the atoms found in nature. Clearly, the Give-and-Receive-Action in these atoms is not complete, resulting in the instability of the manmade atoms.

In this view, the scientists have placed reason (the intellect) as the Center, since most of them are reason-centered and not Heart-centered in their scientific endeavor. If this is any indication that a change of perspective from the intellect-centered to Heart-centered can make such a profound difference in the field of creation, an insight gained from this discussion may provide a clue, as we shall examine, in making Interstellar Travel possible in any foreseeable future.

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[1] http://nhfaithfusion.com/2015/03/the-four-position-foundation/

Entanglement

This disdain in quantum science for the classical rules of how material entities are supposed to behave and how spatial separation is to be respected is even more in evidence in the phenomenon of *entanglement*. This behavior is so anathema to the classical mind that even the Nobel Laureate who first theoretically noticed its possibility —Albert Einstein, no less—vehemently rejected it as "spooky."

A	B	correlation
0°	0°	100%
+10°	0°	90%
0°	–10°	90%
+10°	–10°	**local**: 80% **non-local**: >80%

> Entanglement occurs when two particles are so deeply linked that they share the same existence. In the language of quantum mechanics, they are described by the same mathematical relation known as a wavefunction. Entanglement arises naturally when two particles are created at the same point and instant in space, for example. Entangled particles can become widely separated in space. But even so, the mathematics implies that a measurement on one immediately influences the other, regardless of the distance between them. Einstein and company pointed out that according to special relativity, this was impossible and therefore, quantum mechanics must be wrong, or at least incomplete. Einstein famously called it spooky action at a distance. [1]

Entanglement has been observed for many properties of many entities—such as right/left rotation for photons, ±1/2 spin for electrons, N-up/S-up magnetism for protons, etc.—but we will illustrate the phenomenon with the simplest example: an experiment with the plane polarization of light.

A stream of photons passes through a detector one at a time. If its polarization is parallel to the detector, it outputs a 1; if it is orthogonal, the output is 0. The output will depend on the relative orientation of the polarization and the detector. For example, if they are a parallel 0°, the output is a sequence of 1s; if they are an orthogonal 90°, a series of 0s. If they are at a diagonal 45°, the output is randomly 50% 1s, 50% 0s.

A source emits a pair of entangled photons in opposite directions with identical, but varied polarization. Two detectors, A and B, on either side of the source and with identical orientations measure the polarization of the entangled photons.

The results are 100% correlated—both A and B output either a 1 or a 0:

A: 0011101000111101100

B: 0011101000111101100

In his attempt to avoid accepting a nonlocal aspect to matter, Einstein declared that this correlation was a result of a hidden, local variable carried by the emitted photons. This hidden variable would be

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[1] *Einstein's "Spooky Action at a Distance" Paradox Older Than Thought, 2012*
http://www.technologyreview.com/view/427174/einsteins-spooky-action-at-a-distance-paradox-older-than-thought/

classical and be measured by a real number associated with each photon. In 1935, along with two other authors, he published a paper claiming that Quantum Mechanics was incomplete, and made nonsensical predictions, a viewpoint known ever since as the *EPR Paradox.*

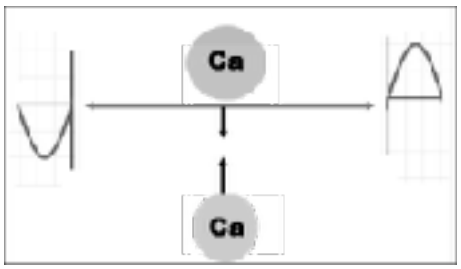
> It is an early and influential critique leveled against ... quantum mechanics. Albert Einstein and his colleagues Boris Podolsky and Nathan Rosen (known collectively as EPR) designed a thought experiment which revealed that the accepted formulation of quantum mechanics had a consequence which had not previously been noticed, but which looked unreasonable at the time. The scenario described involved the phenomenon that is now known as quantum entanglement.[1]

In 1964, a way of differentiating between local and a non-local correlation was formulated, known as *Bell's Inequality.*[2] The math is basically simple (if often shrouded in sophisticated symbolism) and involves not having the detectors at identical orientations. This reduces the correlation between the results at either end.

If the correlation involved local hidden variables (that could not influence each other once separated), the alterations would sum together as real numbers. If the connection was non-local, they would not, and they would add as complex numbers do. [An illustration of how different these are: For two regular numbers with a linear magnitude of 2, adding them together always gives a regular number with magnitude 4. For two complex numbers with magnitude 2, however, adding them together can result in a complex number with a magnitude of anything from 0 to 4 depending on their relative rotations.]

Experiments to test this inequality also had to avoid any possibility of the detectors somehow passing information about their orientations at light speed. If the distance between the two detectors was such that it took 10 nanoseconds for light to cross it, the settings of the detectors had to be altered in 1 nanosecond to prevent any connection at the speed of light.

These experiments have been performed—the most unusual involved kilometers of optic cables threaded through the sewer system of Vienna!—and they have all proved unequivocally that the entangled connection is non-local, instantaneous and independent of the spatial separation. [The concepts briefly mentioned in this section are thoroughly discussed in the book, *The Age of Entanglement.*[3]]



Intergalactic connections

While the indifference of the internal aspect of matter to spatial

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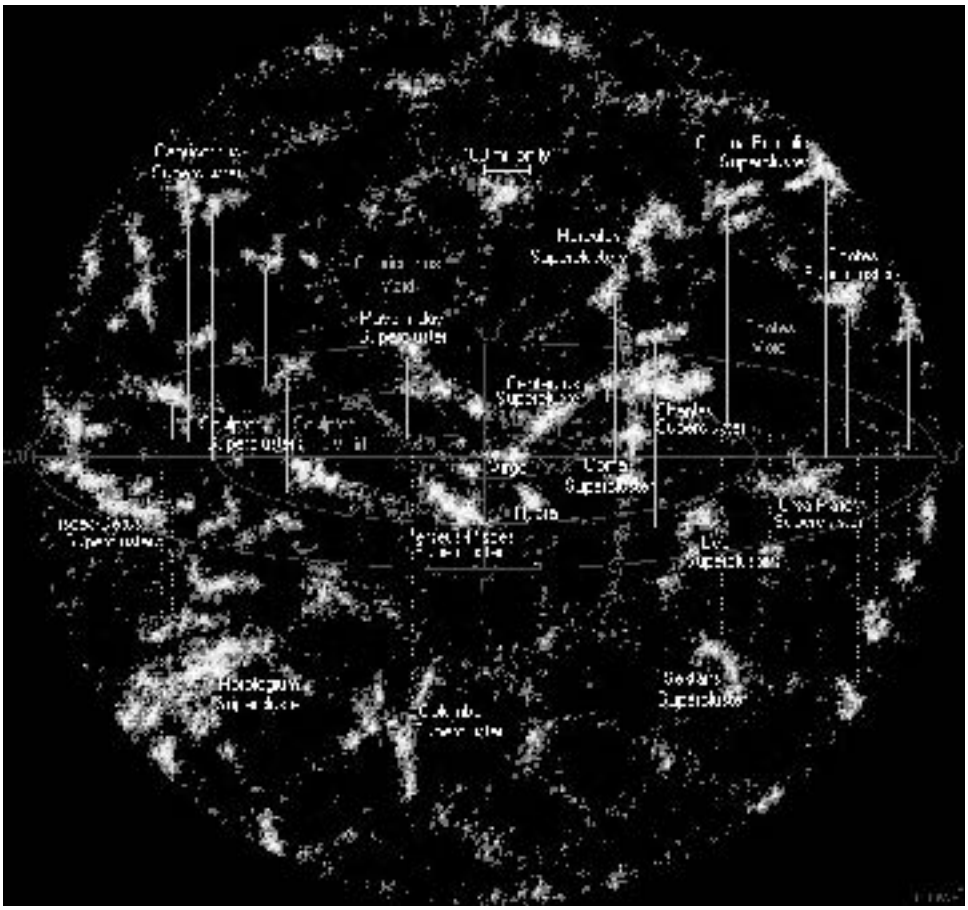
[1] *EPR paradox*_ https://en.wikipedia.org/wiki/EPR_paradox

[2] Bell, John (1964). "On the Einstein Podolsky Rosen Paradox" *Physics* 1 (3): 195–200.

[3] Gilder, Louisa, *The Age of Entanglement: When Quantum Physics was Reborn*, New York: A. A. Knopf, 2008



separation—as illustrated by nodes and entanglement—has been experimentally observed over the range of nanometers to kilometers, there is no theoretical limit to how great the ignored spatial separation can be. This is the foundation for a possible means of interstellar and intergalactic travel.

There are many natural situations in which a pair of entangled entities is emitted. One well-studied example is the calcium atom which, when excited by a thermal collision or absorption of a photon, can revert to the ground state by emitting a pair of entangled photons that zip off in opposite directions.

Calcium atoms floating in space regularly emit such pairs of photons. As mentioned earlier, the internal wave determines what the external particle does, while the external interactions of the particle determine how the wave alters. Unless special care is taken, if either particle interacts externally, the internal wave alters and the entangled state is lost—the phenomenon of *decoherence.*

Luckily, converting what we earlier considered a negative point into a positive, interstellar and intergalactic space are essentially empty, so it is quite possible for these photons to travel for millions, even billions, of years without either of them interacting, while yet retaining the entangled state for millions or billions of years as their spatial separation ever increases.

The star Alpha Centauri is 4 light years distant from us. If 2 years ago a calcium atom directly between us emitted a photon pair, and one of them reached the Earth, the other would be in the vicinity

of Alpha Centauri—a non-local connection between here and there. If a similar thing happened 200 million years ago between here and the Andromeda Galaxy, we would have a non-local connection between the two galaxies.

If the entangled pairs were generated in the last 500 million years, the non-local connections would be spread out in a sphere of with a diameter of 1 billion light years. It is only in the last few decades that techniques have been developed that allow the contents of this sphere to be mapped in some detail.

In this sphere are ~250 quadrillion stars, in ~ 3 million galaxies comparable to the Milky Way, associated into ~100 galaxy superclusters, all of which have been given names. (Our Milky Way Home Galaxy is on the fringes of the Virgo Supercluster at the center of the sphere.) A few of these are shown in the following diagram of a 2-D slice of the universe.[1] It does seem crowded with galaxies, but all are so far away that only the very nearest galaxy, Andromeda, is visible to the naked eye; all the rest require sophisticated telescopes to be observed.

The Observable and Unobservable Universe

All the stars and galaxies in this vast sphere are essentially the same as our galaxies, billions of stars orbiting around a central quiescent black hole of millions, even billions, of solar masses.

As we look further and further into the depths of the universe, however, things start to look very different. At distances over 3 billion light years we start to observe quasars with active black holes at the center, so active that they are visible even at a distance of 13 billion light years. If the Milky Way had such a violent center, life even at our 30,000-light-year distance from the center, would be impossible, the intense radiation would sterilize the earth.

This might seem to set a limit to human intergalactic expansion. Fortunately, contemporary quasars are an artifact of the slowness of light on the scale of superclusters. For we are seeing those far distant galaxies in their formation stage, when the central black hole was forming and clearing out its immediate neighborhood of stars and gas. An observer 10 billion light years distant looking our way would see the Milky Way as a quasar as our central black hole was vacuuming up everything in its vicinity. This youthful exuberance ended billions of years ago, and our central black hole has settled into its amenable middle age.

All those distant galaxies have also settled into middle age, and are no longer in their boisterous youth. Every single galaxy in the entire physical universe is roughly the same age as the Milky Way, They all originated in the gravitational collapse of material generated at the moment of Creation, the Big Bang that occurred ~13.5 billion years ago.

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[1] *The Universe within 1 billion Light Years: The Neighbouring Superclusters*
http://www.atlasoftheuniverse.com/superc.html

One of the few aspects of science history that almost everyone is aware of is that in ancient days everyone—including the Biblical authors—assumed that the Earth was at the center of the universe, and that everything else rotated about the earth. In the 2nd century AD, this geocentric view was successfully compiled by the Hellenistic astronomer Claudius Ptolemaeus in his astronomical work, the *Almagest*. For over a millennium all astronomers assumed this Ptolemaic system was the correct, and only, cosmological model.

One of the first successes of modern astronomy was to displace the Earth from the center of things, and replace it with planets orbiting the Sun. This *Copernican Revolution* in the 1500s was the shift from the Ptolemaic geocentric model to a heliocentric model with the Sun at the center of the Solar System.

As the adage has it: *What goes around, comes around.* This is exemplified by modern cosmology which has replaced the parochial geocentrism of Ptolemy with a cosmic geocentrism that places the Earth at the exact center of the Observable Universe. Again this is due to the tardiness of light of light on the cosmic scale. For in a universe that is only 13.5 billion years old, the most distant things we can observe are those whose light can reach us in that time period. Anything more distant cannot be observed.

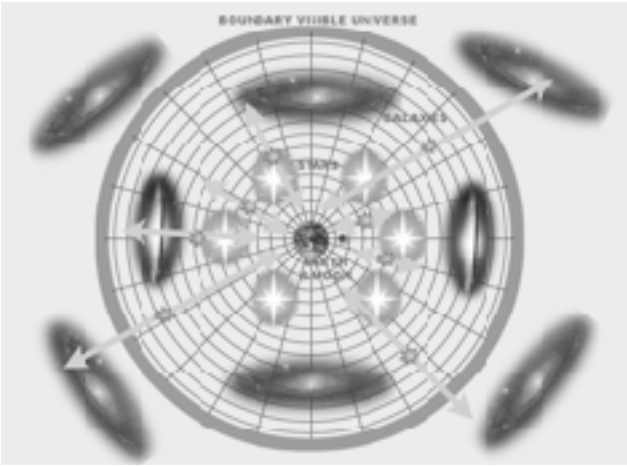
The distance of 13.4 billion light years defines the boundary of the Observable Universe, a perfect sphere with us at the very center. The surface of this sphere is created by the Recombination Era—the time when the expanding universe had cooled to well below the surface temperature of the Sun and the plasma of free electrical entities (as found inside the Sun and neon tubes) could condense into neutral atoms and the light could travel unimpeded through empty space. This light has been stretched nowadays into the Cosmic Microwave Background, and beyond this barrier nothing is observable in any variety of light.

This boundary to the Observable Universe is uniform to 1 part in 10,000. At greater resolution, however, speckles of slightly hotter or cooler temperatures are observed—shown in orange and blue respectively in the following photo of the boundary to the Observable Universe taken recently by the European Space Agency's PLANCK Mission.[1]

The rest of the physical universe, the Unobservable Universe, is also the same age as the Observable Universe, and contains a plethora of galaxies of stars and planets just waiting to be explored. Estimates of how much larger this unobservable universe is compared to the observable universe vary from a

[1] http://www.esa.int/spaceinimages/Images/2013/03/Planck_CMB

moderate 250 times larger[1] to a mind-boggling 300 billion trillion times larger[2]. Given the power of geometric growth, I would suggest that God's Original Plan embraces the larger, rather than the smaller, estimate.



Luckily for our descendants who will be looking for planets to populate, the seeming barrier between these two parts of the universe is utterly transparent to the entangled non-local connection we are discussing. An entangled pair of photons created 10 billion years ago would be separated spatially by 20 billion light years. One entering our solar system would have its twin well inside the unobservable universe, and provide a non-local connection between the two.

As hitting the earth's atmosphere and interacting with a gas molecule would cause decoherence, the best place to harvest these interstellar, intergalactic and interuniverse connections would be on the airless Moon—a great example of the Creator's planning ahead. Not that the Moon has not already proved itself invaluable, even essential, over the eons.[3]

With the insight provided by quantum physics, we find that our Moon is constantly bombarded with a plethora of non-local connections to locations scattered over the entire physical universe. This is certainly the kind of situation that the *Divine Principle* leads us to expect. A caveat should be noted at this point: Even though these entangled connections uncovered by 20th century physics seem to provide the expected interstellar connections, the beneficent Creator might have had quite a different travel plan in mind, intimations of which are unknown to current science.

Future Developments

It is disappointing, I know, because this is about as far as we can go, since Entanglement science and technology are only in their infancy. I would be delighted to expound on how entanglement-created Intergalactic Connections are physically related to Interstellar Travel. But this is the work of the next few centuries—all we know is that God must have planned for intergalactic travel, and that we know of a natural source of intergalactic connections. Putting the rest of the picture together is the task for the generations to come.

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[1] Vanessa D'Amico *Universe Could be 250 Times Bigger Than What is Observable* 2011 http://www.universetoday.com/83167/universe-could-be-250-times-bigger-than-what-is-observable/

[2] Alan H. Guth. *The Inflationary Universe: The Quest For A New Theory Of Cosmic Origins*. New York: Basic Books, 1997. p. 186.

[3] Comins Neil F.,*What If the Moon Didn't Exist?: Voyages to Earths That Might Have Been*, New York: Harpercollins, 1993

This formation stage of Entanglement Science can be likened to that of Electromagnetic Science and technology around 400 years ago when Luigi Galvani was twitching frog muscle with silver and copper wires in the late 1700s, and Michael Faraday was waving wires and magnets at each other in the early 1800s. On such simple foundations was built the Age of Electricity in just three centuries. (I can testify to the cultural importance of electricity, having personally experienced the Great Blackout of New York City in 2003.)

Current understanding has no clue, for instance, as to how to manipulate such non-local connections for communication, let alone bodily travel. Trapping entangled particles without decoherence is also a problem. Progress is being made, however, such as moving beyond entangled pairs to entangled multitudes:

> The largest number of particles that has been entangled so far is four. However, the Innsbruck-Aarhus team claim that their [Bose-Einstein condensate] technique could eventually be used to entangle any number of atoms.[1]

One problem is that most scientists are external materialists—they feel uncomfortable about including an internal aspect in their speculations about what is possible. So disagreeable is this internal aspect that most scientists try to ignore it as soon as possible. The internal aspect is dominant in physics, useful in chemistry, and mentioned in basic biochemistry (where the prevailing model is the external fitting together of lock and key). The internal aspect of matter, however, is essentially absent from biology, genetics and neuroscience; it is totally ignored as if it did not exist.

A scientist familiar with Unificationism, however, is quite comfortable with the concept of a subjective internal aspect and is equipped to go where others are not. In my book, *Unified Science and Unification Thought*[2] I view modern science through the perspective of internal/external duality, as well as exploring the digital/analog duality evident in living systems.

The coming generations of Unificationist scientists will develop a flourishing science and technology based upon unified dual characteristics, and I hope will be pioneers of interstellar travel so that Blessed families can populate the Universe without limit.

It would have been impossible, even for a practical genius such as Michael Faraday, to take the contemporary understanding of electricity in the 1800s and predict the technology of GPS navigation, iPhones and the international Internet. Similarly, it is impossible to accurately predict what the Age of Entanglement will provide in the way of interstellar transportation. But that does not mean that we cannot speculate with the little that is already understood, creating the following blend of known science and science fiction.

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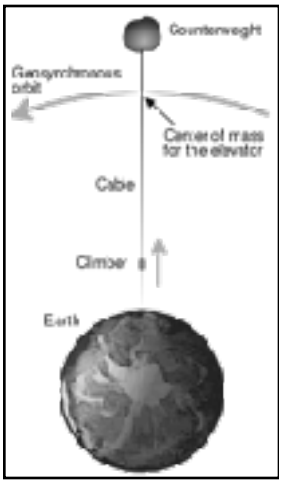
[1] http://physicsworld.com/cws/article/news/2000/jun/29/quantum-entanglement-spreads-to-bose-condensates

[2] Available in book form from Amazon.com and Lulu.com, and electronically from Lulu.com

The Future

Current research into entanglement is restrained by the constant struggle to avoid decoherence. The atmosphere about us is packed with molecules darting around with thermal energy, ready and able to interact at any moment and destroy the entangled state. To avoid this, experiments have to be performed in small leakproof apparatuses, where an expensive high vacuum can be maintained, and usually at liquid nitrogen temperatures or lower.



On the Moon things are quite the opposite. Vacuum and low temperatures are the norm so experiments can be performed in the vast open space, and it is the scientists who are maintained inside leakproof accommodations kept at room temperature. In other words, the perfect place for the science of entanglement to make rapid advances is a Moon base. As already mentioned, it is the only convenient place to collect naturally-entangled cosmic rays.

Even though the Moon, on an intergalactic scale, is right next door to us here on Earth, traveling to and from it using conventional chemical rockets is costly and fraught with problems. This inconvenience would be obviated by a *space elevator*, schematically illustrated on the right.[1]

> A space elevator is essentially a long cable extending from our planet's surface into space with its center of mass at geostationary Earth orbit, 35,786 km in altitude. Electromagnetic vehicles traveling along the cable could serve as a mass transportation system for moving people, payloads, and power between Earth and space.…Four to six "elevator tracks" would extend up the sides of the tower and cable structure going to platforms at different levels. These tracks would allow electromagnetic vehicles to travel at speeds reaching thousands of kilometers-per-hour.[2]

The space elevator is an idea that has been around for decades and only needs one technological advance to become feasible—a material that is lightweight yet 50 times as strong as steel. Diamond would do nicely, but nobody has come up of a inexpensive way of making synthetic diamond in the huge quantities that would be required.[3] Cables of defect-free graphene—a distant cousin of diamond that is already being synthesized—might be up task:

> Graphene is the strongest material in the world, according to new experiments done by researchers at Columbia University in the US. The secret to the material's extraordinary strength, says the team, lies in

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[1] Diagram at: http://www.newworldencyclopedia.org/entry/Space_elevator

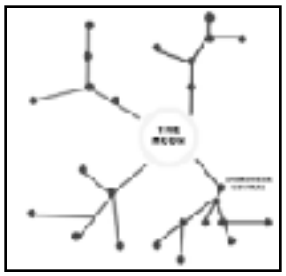
[2] NASA *Audacious & Outrageous: Space Elevators, 2000*
http://science.nasa.gov/science-news/science-at-nasa/2000/ast07sep_1/

[3] Dr. Lewis has written some unpublished speculations about a plausible method for such synthesis. If interested, you can send a request for the paper to the email address provided at the end of this paper.

> the robustness of the covalent carbon-carbon bond and the fact that the graphene monolayers tested were defect-free.[1]

It is, perhaps, thus only a matter of time before cables capable of handling the space elevator are available and the Moon becomes accessible. So, for the first step in our future speculation, we postulate a space elevator facilitating inexpensive travel between earth and Moon. Following this, establishment of a science facility on the Moon focusing on studies of manmade and natural entanglement.

We will allow a century to pass until the technological manipulation of non-local connections becomes established.



The scientific foundation on the Moon then switches to the harvesting of the enumerable entangled particles that arrive every second, opening the non-local connection and seeing where the other end of the connection is located. Some of the recently created pairs will have their outer ends near the planets—a much better way to explore Mars than spending years in chemical rockets.

Most outer ends will be found, statistically speaking, in the great empty voids of space, either galactic or intergalactic. Amidst such dross will be the occasional jewel—a connection in the vicinity of another star. Telescopic examination through the non-local connection will determine if there are any potentially habitable planets. If there are, the connection will be opened wide and exploratory vehicles sent to investigate.

When a suitable planet is found, migration of families—hopefully true families—will commence. Once the essentials of civilization have been taken care of, a facility for harvesting the local showers of entangled particles will be created.

After a few centuries, a web of non-local connections between the stars and galaxies will be established. Such a non-local web will be traversed not by spaceships but subway cars, and humanity will spread God's kingdom of true love to the stars.

Epilogue

Science has established that the physical universe has an 'expiration date' inherent in its structure—luckily many tens of billions of years in the future. This eventual end is, basically, because the energy of the stars that warm planets and nourish plant life is derived from fusing the primordial hydrogen created in the Big Bang into helium over time. For instance, our Sun gets its energy by converting, every second, ~600 million tons of hydrogen into ~596 million tons of helium and generating ~4 million tons of energy in its core, which then makes its way slowly—taking about a million years—to the surface where it is radiated out into space, a tiny fraction of which warms and nourishes us here on Earth. In 10

[1] *Graphene has record-breaking strength*, Jul 17, 2008
http://physicsworld.com/cws/article/news/2008/jul/17/graphene-has-record-breaking-strength

billion years or so, our Sun will have consumed all its natal hydrogen and will shift to converting helium into carbon and oxygen. Unfortunately for our descendants, this will convert our Sun into a Red Giant with a diameter that will engulf Venus. Earth's oceans will boil away and become unlivable unless something drastic is accomplished.

One possible solution would be to open a truly gargantuan non-local connection and pass the Earth through it to an orbit around a young star. There are actually great clouds of tenuous hydrogen scattered throughout the galaxies, and new stars are being created out of these at a rate of about 10 per year. While the supply of this hydrogen is enormous, it is not infinite. When all the hydrogen is used up—and this will occur everywhere at about the same time—this physical universe will no longer be suitable for our kind of life.

We can assume that God has taken this into account, and that provision has been made for new and fresh universe to be created by humanity. The technology to generate a Big Bang will be developed—if Dad can do something, so can His children. But all this is so far beyond our current understanding that we would do well here to suspend any further speculation.