Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part I

(revised March, 2009)

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The Charges of Matter are the Symmetry Debts of Light

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Abstract:

The conceptual basis of the Unified Field Theory, as presented in these pages, can be briefly sketched as

follows:

"Noether's Theorem" states that in a multicomponent field such as the electromagnetic field (or the metric field of spacetime), where one finds a symmetry one finds an associated conservation law, and vice versa. In matter, light's symmetries are conserved by charge and spin; in spacetime, by inertial and gravitational forces. All forms of energy, including the conservation/entropy domain of spacetime, originate as light. During the "Big Bang", the asymmetric interaction of primordial, high energy light with the metric structure of spacetime produces matter; matter carries charges which are the symmetry (and entropy) debts of the light which created it. Charges produce forces which act to return the material system to its original symmetric state (light), paying matter's symmetry/entropy debts. Repayment is exampled by matter-antimatter annihilation reactions, particle and proton decay, the nucleosynthetic pathway of stars, and Hawking's "quantum radiance" of black holes. Identifying the broken symmetries of light associated with each of the 4 forces (and charges) of physics is the first step toward a conceptual unification of those forces.

In the "global vs local gauge symmetry" representation of the cosmic conservation mechanism, the global symmetry is carried by massless light, space, absolute motion (the intrinsic and invariant motion of light), and "gauged" (regulated) by "c", the universal electromagnetic energy constant. The local symmetry is carried by massive matter, various charges, causal history, relative motion (including the intrinsic but variable motion of time) and gauged by "G", the universal gravitational constant. Connecting these two realms of free vs bound electromagnetic energy (and their conservation domains of space vs history), are the field vectors of the forces, whose function is to translate the invariant symmetry of the global realm into the invariant charges, spin, mass, and "interval" of the local realm, and vice versa, conserving energy, symmetry, entropy, and causality, throughout both conjoined domains. (See: [The Tetrahedron Model (diagram)](#)".)

I will employ the "global vs local gauge symmetry" representation of the cosmic conservation process (due to the "Standard Model" of "establishment" physics) throughout the following analysis, in combination with certain symmetry principles, as elucidated by the "[Tetrahedron Model (text)](#)" originating in these web pages: *the charges of matter are the symmetry debts of light*". Four conservation laws and corollaries (energy, entropy, symmetry, causality); Noether's Theorem; and a few invariance principles: (charge, elementary particle mass, velocity c, the "Interval", causality, Lorentz invariance of Special Relativity, etc.), are the key to understanding the operation of the forces and the unified field theory. (See: [Global vs Local Gauge Symmetries in the Tetrahedron Model](#)".

Row 1 - Symmetric Energy States and the "Big Bang"

Note (1): I recommend the reader consult the "preface" or "guide" to this paper, which may be found at "[About the Papers: An Introduction"](#) and "[The Sun Archetype](#)". Because this paper is already too long, I have "farmed out" the discussion of several major but complex topics, including "[cosmology](#), "[gravitation](#), "[entropy](#), the "[weak force](#), etc., to other papers on my website devoted solely to those topics. The reader must consult these (and related) papers if a thorough discussion of these topics is desired.

Note (2): The format of this paper ("Row 1", "Row 2", etc.) follows a [4x4 table](#) which the reader should access and print out for ready reference (also available at the end of this paper). This table provides a convenient way to organize an extensive subject matter, and is furthermore part of a "[General System, or Fractal Model of the Universe](#), which facilitates comparison and correlation with other "world systems". An

introductory paper: "["Synopsis of the Unification Theory: The System of Spacetime"](#)" provides a general summary of the topic.

Note (3): Symmetry in nature is found in many forms. The symmetries of the four forces usually discussed by "establishment" physics in the context of unification are mathematical, derived from the "group theory" of Evariste Galois, Sophus Lie, and Wilhelm Killing. These generally describe "rotations in phase space" in which particles, forces, and/or actions are rendered indistinguishable from one another (see Ian Stewart: "Why Beauty is Truth" (Basic Books 2007) for an expert discussion at the layman's level of the mathematical symmetries of the Lie groups). Because I worked independently of the mathematical physics "establishment", I discovered and used a different set of symmetries to achieve a unification among the forces. "My" symmetry principles are derived from (my own reading of) Noether's Theorem: *the charges of matter are the symmetry debts of light*. The two sets of symmetry principles actually complement each other, illustrating the great value of independent approaches to a common problem. Both come together in the "[Table of the Higgs Bosons and Weak Force IVBs](#)". For another view of the synthesis between my own and the establishment's version of unification, see: "[The 'Tetrahedron Model' vs the 'Standard Model': A Comparison](#)"; and: "[Global and Local Gauge Symmetries in the Tetrahedron Model](#)".

Note (4): In each of the four rows below I suggest a financial metaphor for the energetic process characteristic of the row, beginning with the assumption of a debt, followed by two contrasting payment modes, and ending with a full repayment. The intent is to help the reader gain an overview of and feeling for the unfolding energy budget of the Cosmos as outlined in this model, by reference to another quantitative system with which we are all familiar.

Row 1: Incurring the energy, entropy, and symmetry debt - "taking out a loan, opening a mortgage contract" - symmetry-breaking during the Big Bang. Important concepts in Row 1 include the nature of light and its intrinsic motion, as gauged by "velocity c"; the establishment of the spacetime metric; "Noether's Theorem" and the conserved symmetries of light; the interaction of light with metric space to create the particle "sea" or "zoo"; and finally, the breaking of the symmetry of light, the spacetime metric, and matter-antimatter particle pairs by the asymmetric interactions of the weak force with matter vs antimatter. Symmetry-breaking results in the creation of isolated particles of matter - the atoms which form our material Universe.

How the Universe actually begins (for example, "inflationary" scenarios) is not considered in this account (see: "[The Origin of Matter and Information](#)" and "[The Higgs Boson and the Weak Force IVBs](#)" for "genesis" scenarios). I assume, however, that the initiating positive energy is completely balanced by some type of negative energy (such as gravity). Furthermore, it is not unreasonable to suppose that our Universe is but one of many (a member of the "multiverse"), whose unique physical constants are constrained only by the "anthropic principle" (must allow the evolution of our life form), and the requirements of energy conservation within such a complex Universe.

[Begin Table:](#)

Light
(row 1, cell1)

The Universe begins with light (in physics, as in many "genesis" mythologies) - free electromagnetic energy - which is a perfectly symmetric energy form. Light is massless, carries no charges of any kind, "[produces no gravitational field](#), and has no time dimension in the ordinary sense. Light's intrinsic motion (gauged by "velocity c") is the primordial spatial entropy drive of free energy, and also the gauge of a "non-local" symmetry condition formally characterized by Einstein as light's zero "Interval" (the "Interval" of light = 0). Light's zero "Interval" (the "Interval" is an invariant measure of spacetime) mathematically defines light's

symmetric energy state of "non-locality".

Light is a 2-dimensional transverse wave whose intrinsic motion sweeps out a third spatial dimension. Lacking both a time dimension and one spatial dimension (in its direction of propagation), light's position in 3-dimensional space or 4-dimensional spacetime cannot be specified. Since both time and distance are meaningless to light, and yet light has intrinsic motion, light has in effect an infinite amount of time to go nowhere. Hence in its own reference frame (moving freely in the vacuum of spacetime at velocity c), light must be considered to be everywhere simultaneously. From this results the "non-local" (and therefore atemporal and acausal) symmetric energy state of light. "Non-locality" is the primary symmetry condition of massless free energy, and its chief distinction from massive, local, temporal, and causal bound energy. Several other symmetries are associated with light's non-local energy state, all of which require conservation (in accordance with "Noether's Theorem" - see below).

Light's "zero Interval" means that light is everywhere throughout its conservation domain simultaneously - a symmetry condition with respect to the distribution of light's energy in spacetime ("symmetry" refers to a condition of balance, sameness, or equality). It is due to this symmetry condition that we can (in theory) circumnavigate the Universe within a human lifetime - in a rocket ship moving at nearly velocity c. At exactly c it takes no time at all (time does not exist - clocks stop - at velocity c).

The electromagnetic constant c is the universal "gauge" or regulator (in the sense of railroad track or wire gauges) for the "metric" of spacetime, the fixed relationship which establishes the equivalence of measurement within and between the dimensions: 300,000 km of space is metrically equivalent to 1 second of time. At c this equivalence is complete and time is suppressed to a locally implicit state (light has no time dimension). The suppression of the asymmetric time dimension (and time's asymmetric companions, mass, charge, and gravitation), and the equilibration of the 3 spatial dimensions, is the principle symmetry-keeping function of c. To think of c as a velocity, even as a "non-ordinary" velocity, is to miss the point: the physical significance of c is that c gauges both light's non-local symmetric energy state and light's primordial spatial entropy drive. It is because of these "gauge" functions that c appears to us as an effectively "infinite" and invariant velocity. Another famous gauge function of c (also discovered by Einstein) fixes the energetic equivalence of free to bound electromagnetic energy: $E = mcc$. "c" also functions as the gauge or messenger of causality (via the "Interval"). These various gauge functions (among others) indicate the primacy of light in our Universe - and the fundamental significance of Einstein's Theory of Special Relativity.

The Metric of Spacetime
(row 1, cell 2)

Imagine a Universe of pure light, before the creation of matter, in which the metric is everywhere the same, as no gravitational fields are present to disturb its symmetry. The metric is a necessary condition of the spatial domain, as it is the regulatory structure and mechanism which performs the conservation function of the domain (via "inertial" forces), controlling and coordinating the rate of expansion and cooling of space both globally and locally, regardless of the changing size of the Universe. It is for this reason that a "non-local" metric gauge such as c is required - one whose regulatory influence can be everywhere simultaneously, irrespective of the physical extent (or rate of expansion) of its domain. Both space and its metric are created by the intrinsic motion of light. Without the metric every photon could have a unique velocity; it is the metric which imposes the universal constant c upon them all. While we conceive of the metric as produced by light, the metric's origin is in the inherent energy conservation parameters of light, including entropy (intrinsic motion) and symmetry (non-locality).

The primordial entropy drive of light (free electromagnetic energy) is expressed through its intrinsic motion, expanding and cooling the Universe, hence reducing the Cosmos' capacity for work. But it is light's intrinsic

motion which also creates the conservation domain of spacetime and maintains its metric symmetry, suppressing time, equilibrating the spatial dimensions, etc. Therefore light and space are related through the first and second laws of thermodynamics, while c functions to gauge both the primordial entropy drive and the non-local symmetric energy state of light. It is the function of entropy's primordial form to create a dimensional conservation domain in which energy can be transformed, used, but nevertheless conserved. Without entropy (the 2nd law of thermodynamics), the Universe could not spend its energy capital, since the 1st law of thermodynamics (energy conservation) would forbid any use of energy at all. The dimensions of spacetime are entropy domains, created by the intrinsic (entropic) dimensional motions of light (creating space), time (creating history), and gravitation (converting space to time and vice versa), as gauged by "c" (the intrinsic motion of light), "T" (the intrinsic motion of time), and "G" (the gravitational constant). (See: ""A Description of Gravitation".)

The intrinsic motion of time is also primarily gauged by c as the temporal duration (measured by a clock) required by light to move a given distance (measured by a meter stick). G is the entropy conversion gauge, fixing the volume of space which must be annihilated and converted to time per unit mass. Gravitation converts the entropy drive of free energy (the intrinsic motion of light as gauged by velocity c) to the entropy drive of bound energy (the intrinsic motion of time as gauged by velocity T) and vice versa (as in the conversion of bound to free energy in stars). (See: "Spatial vs Temporal Entropy".)

Our physical Universe, including the conservation domain of spacetime, is wholly the product of a single form of energy - electromagnetic energy (the "monotheism" of physics). Light is the most primordial form of this energy, which we know because light has the greatest symmetry of any energy form, and provides the basic gauges, both metric and energetic, for either free or bound electromagnetic energy. Light is the only energy form which can produce its own conservation domain from its own nature (intrinsic motion c) - matter must produce its historic domain from preexisting space via the gravitational conversion of space to time. Finally, light is the form from which all other kinds of energy are created, and to which they all reduce and return (as in matter-antimatter annihilations). (See: "Entropy, Gravitation, and Thermodynamics".)

Noether's Theorem

"Noether's Theorem" (Emmy Noether, 1918) states that in a multicomponent field (such as the electromagnetic field, or the metric field of spacetime), where one finds a symmetry, one will find an associated conservation law, and vice versa. Noether's Theorem is saying that in the conversion of light to matter (for example), not only must the raw energy of light be conserved in the mass and momentum of particles, but the symmetry of light must also be conserved - not only the *quantity* but the *quality* of energy must be conserved.

Before symmetry-breaking we find Noether's Theorem expressed through: 1) the inertial forces of metric symmetry-keeping as gauged by "velocity c", suppressing the asymmetric time dimension; 2) through the electrical annihilation of particle-antiparticle pairs, suppressing the asymmetric appearance of any immobile bound energy form, whether matter or antimatter. *After* symmetry-breaking (in the "Big Bang"), we find additional expressions of Noether's Theorem in: 1) the metric fields of gravitation and time; 2) the conserved charges (and spin) of particles - which all work together (as in our Sun) to return asymmetric matter to its original form of symmetric light. The gravitational process (of symmetry conservation) drives to completion via Hawking's "quantum radiance" of black holes.

I think of Noether's theorem as the "Truth and Beauty" theorem, in reference to Keat's great poetic intuition:

> "... Beauty is truth, truth beauty, - that is all
> Ye know on earth, and all ye need to know"

("Ode on a Grecian Urn": John Keats,1819)

in which Beauty corresponds to Symmetry and Truth corresponds to Conservation.

The two common examples of Noether's Theorem enforced in Nature - charge (and spin) conservation among the particles, and gravitational and inertial forces in the spacetime metric - are the more enlightening because the former (charge) is an example of symmetry conservation and debt payment deferred indefinitely through time, while the latter (inertia) is an example of raw energy conservation in which the debt must be paid immediately. Furthermore, in the case of inertial forces, we see the implication that gravitation will also fall under the conservation mantle of Noether's Theorem, via Einstein's "Equivalence Principle". This indication is borne out and verified by the discovery that gravitation is indeed a symmetry debt of light, responding to, conserving, and finally restoring the non-local spatial distribution of light's energy, a symmetry broken by the immobile, undistributed concentrations of mass energy (E = mcc) represented by matter.

Noether's theorem tells us why the basic forces of nature are all busy converting matter to light: matter was created from light in the "Big Bang", but since light has greater symmetry than matter, it is to conserve light's symmetry that all the charges and forces of matter work to accomplish the return of bound energy to its original symmetric state. *The charges of matter are the symmetry debts of light*. These charges produce forces which act to return the system of matter to light (free energy). Our Sun is an archetypical example of symmetry conservation in nature; the radiance of our star is the evidence of a completed symmetry conservation circuit. (See: "Currents of Symmetry and Entropy".)

A Conceptual Unification

A program of unification is therefore clearly indicated by Noether's Theorem: identify the (broken) symmetries of light carried, represented, and conserved by the charges of matter. The actions of the forces produced by these charges should offer clues as to what these (broken) symmetries are. This will allow us to refer all the charges and forces of matter to their common origin as specific symmetries of light, accomplishing our conceptual unification. Matter is but an asymmetric form of light, as time is an asymmetric form of space, and gravity is an asymmetric form of inertia. The charges and forces of matter act to return bound energy to its symmetric, original state of free energy, in obedience to Noether's Theorem. In the pages which follow, we will follow out this simple conceptual program of force unification, by identifying the broken symmetries of light represented by the conserved charges of matter - including gravity's "location" charge. While this is a conceptual rather than a quantitative unification, is is hoped that by framing the argument firmly within the constraints of the conservation laws, a pathway to a more formal, quantitative, mathematical unification will at least be indicated. (See also: "The 'Tetrahedron Model' vs the 'Standard Model' of Physics: A Comparison".)

Particles
(row 1, cell 3)

Matter consists of two types of massive particles, the elementary particles with no internal parts, called leptons, and composite particles with internal parts (quarks) called hadrons. Together they comprise atomic matter, the electron a member of the lepton family, and the nuclear particles (protons and neutrons) examples of the hadron family. Hadrons containing a quark-antiquark pair are known as mesons, while those containing 3 quarks are called baryons; no other quark combinations are thought to exist in nature - at least commonly (see: *Discover* "The Year in Science" Jan. 2006 page 39). (See: "The Particle Table").

Together, light and metric spacetime have the capacity to produce particles, which are essentially a "packaging" of light's free energy. The mechanism by which the primordial transformation of free to bound

electromagnetic energy occurs is still unknown, although actively investigated. We believe our Universe began as an incredibly hot, energy dense, and spatially tiny "singularity" (the standard "Big Bang" model - see Steven Weinberg's "The First Three Minutes"). One can readily appreciate that a simple "packaging" mechanism for compactly storing the wave energy of light - which by its very nature (its intrinsic motion) takes up a lot of space - would be useful in the spatially cramped conditions of the initial moments of the Big Bang.

In a purely pragmatic way the "packaging" concept accounts for the existence of particles and some of their salient features: the spectrum of identical elementary particles of various masses (the leptonic series), the heavier ones presumably more useful "packages" at earlier times and higher energy densities, and similarly, the spectrum of composite particles (baryons), which can store additional energy internally, as if they contained a set of compressible springs (the quarks). Finally, massive particles can store an unlimited quantity of energy as momentum, a feature of particular utility in the early Universe, helping to avoid the "still birth" of a cosmic "black hole". (The conversion from a spatial (free energy) to a temporal (bound energy) entropy drive, preserving the Universe's capacity for work by storing energy as immobile, non-expanding mass ($E = mcc$), is perhaps an even better "reason" (from the "anthropic perspective") for the initial conversion of light to matter.) Still another argument favoring the existence of mass is that the gravitational field of massive particles provides a form of negative energy which exactly balances the positive energy of the "Big Bang", allowing the Universe to be born as a quantum fluctuation of the "void" or "Multiverse", containing no net energy at all (as in Alan Guth's theory of "inflation").

I presume there is a mechanical or "resonant" relationship between the metric of spacetime and the structure of particles - the dimensional structure of spacetime is carried into, reflected in, or otherwise directly influences, the structure of particles. Light exists as a 2-dimensional energetic vibration of the metric structure of spacetime. Usually this energetic vibration is simply transmitted by the metric grid at velocity c, the "inertial" symmetry condition imposed upon light by its conserving metric. However, it is also possible for this vibrational energy to become "entangled" in the metric and tie itself into higher dimensional "knots", which cannot be transmitted at c because they are no longer 2-dimensional. The elusive "Higgs boson" is thought to play a central regulatory or "gauge" role in these entanglements, endowing the elementary particles with mass (see: "The Higgs Boson vs the Spacetime Metric"). Such metric "knots" comprise particle-antiparticle pairs, and their energy, structure, and information content is derived from the mixture of metric spacetime and light's energy. The otherwise inexplicable existence of three energy families of both quarks and leptons is probably a consequence of the origin of particles as electromagnetic "knots" in the 3 spatial dimensions of the metric. The mathematical/geometric connection between energy, the metric, and the structure of particles is currently being investigated (in 10 or 11 dimensions!) by "string" theory (see Brian Greene's "The Elegant Universe"), and by "Group Theory" (see Ian Stewart's book, referenced above). In this paper, however, I sketch much simpler ideas in the usual 4 dimensions. (The totality of historic spacetime may be conceived as 5 dimensional - or even 8 dimensional - see: "Juan Maldacena's 5-Dimensional Universe".)

It remains a mystery how the elementary leptons are related to the composite baryons, but it is plausible that this relationship is through an ancestral, heavy, leptonic particle (the "leptoquark"), which "fractured" under the high pressure of the Big Bang, and so could arrange its internal fractional charges in electrically neutral configurations - as in the neutron. This notion is based on the theory of "asymptotic freedom" (Politzer, Gross, Wilczek - 2004 Nobel Prize) - a symmetry principle which observes that as the quarks of a baryon are squeezed together, the strong force which binds them becomes weaker, affording the quarks more freedom of movement. If the quarks are squeezed together completely - as by the ambient pressure of the "Big Bang", the ""X" Intermediate Vector Boson (IVB) of the weak force, or the gravitational pressure of a black hole - the color charge of the gluon field sums to zero (see Row 4, "Gluons", below), leaving a particle indistinguishable from a heavy lepton, the hypothetical "leptoquark". A "colorless" and electrically neutral leptoquark would therefore be susceptible to a typical weak force decay via a leptoquark neutrino

and the "X" IVB, hypothetical particles we examine in the following section. (See also: "[The Origin of Matter and Information](#)".)

Symmetry Breaking and the Weak Force
(row 1, cell 4)

Leptons as Alternative Charge Carriers

The leptonic elementary particles (charge-bearing particles with no internal parts or sub-units, exampled by electrons and neutrinos) function as alternative charge carriers for the hadrons (mass-bearing particles containing quarks). Without these alternative charge carriers (electrons carry electric charge, neutrinos carry number or "identity" charge), the massive hadrons would remain unmanifest, locked in symmetric particle-antiparticle pairs, forever annihilating and reforming. (Mesons also function as alternative charge carriers for the partial charges of quarks, especially in transformations of baryons.)

In fact, we discover that in order to produce an asymmetric, "singlet" particle of matter from a symmetric particle-antiparticle hadron pair, we require: 1) an electrically neutral, composite, primary mass-carrying field (quarks bearing partial charges, similar to a neutron); 2) a secondary field of alternative charge carriers (electrons, neutrinos, and mesons); 3) the secondary field must furthermore be asymmetric in its interaction with the primary field, such that its reactions with particles proceed at a different rate than its reactions with antiparticles; 4) interactions between the hadron and lepton field must be brokered by a third quantized mediating field, the Higgs boson and the Intermediate Vector Bosons (IVBs) of the weak force, the W, Z, and X particles (in which the asymmetric principle is probably located; IVBs and the scalar Higgs function to regulate and standardize the reaction pathway and products, such that all elementary particles (of a given species) are exactly alike whether created today or in the "Big Bang"); 5) a final requirement is that there must exist some fundamental basis of similarity between all three fields if they are to interact at all - they must be able to recognize and mesh with each other at the quantum level of charge. For example, the electrical charge of the proton must be exactly equal in magnitude to that of the positron or electron (hence the supposition of their common origin in the leptoquark). (See: "[The Higgs Boson and the Weak Force IVBs](#)".)

Obviously, the relationship between the hadrons and leptons must be intimate, and almost certainly they are related through ancestry, that is, one is derived from the other, both are derived from the metric, both are decay products of the leptoquark, etc. A complex arrangement, but nothing less will suffice to break the initial symmetry of free energy and the particle-antiparticle pairs it so abundantly produces. Matter is only a complex as it must be to break symmetry and still conserve energy and charge. Free energy is flirting with the danger of manifestation in the ready creation of such virtual particle-antiparticle pairs, and in the end it pays the price, as flirts usually do. (See: "[The "W" IVB and the Weak Force Mechanism"](#)").

IVBS - Quantum Process and Particle Transformation

The field vectors or force carriers of the weak force are known as Intermediate Vector Bosons, or IVBs. The IVBs include the W+, W-, and Z (neutral) particles. As a group, they are the most unusual particles known and the most difficult to understand (I also include in this group the hypothetical super-heavy "X" particle thought to be responsible for producing leptoquark and proton decay.) The charge carried or mediated by the IVBs is the "number" or "identity" charge of the weak force. The weak force only creates or transforms "singlets", unpaired elementary particles, which must be invariant in all their attributes (mass, charge, spin, etc.) no matter where or when they are created. It is this heavy conservation constrain upon its operation and products that explains the cumbersome and exotic mechanism of the weak force.

The weak force is the asymmetric and symmetry-breaking physical mechanism that produces elementary

massive particles from light (more specifically, from light's particle-antiparticle form), and governs the creation, destruction, and transformation of elementary particles, both quarks and leptons. Only 3 massive leptonic elementary particles are known, the electron, muon, and tau, identical in all their properties other than mass and identity ("number") charge. This is the leptonic particle family, series, or spectrum. It is a quantized mass series, each member separated from the others by a large, discreet, and exact mass difference. (I suspect the leptoquark is the 4th and heaviest member of this series, representing the primordial common ancestor of the baryons and leptons.) It is the role of the IVBs to mediate or broker the transformation, creation, and destruction of the elementary leptons, and transformations of quark "flavors" in certain situations, notably in the decays of baryons. The "Z" governs electrically neutral weak force interactions in which neutrinos simply scatter ("bounce") or swap identities; the super-heavy "X" is hypothesized to govern proton and leptoquark decay. The actual weak force transformation mechanism is discussed below. (See also: "[The Weak Force: Identity or Number Charge]").

What is most remarkable about the IVBs is that they seem to be "metric" particles providing "[bridges between real particles and their counterparts] in the "virtual particle sea" of the vacuum. The IVBs are not particles like the leptons and baryons which form stable matter; they are particles of interaction, present only when mediating a reaction, "virtual" particles usually known only by their effects, existing within the "Heisenberg Interval" for virtual reality, but real enough and producible as distinct, massive entities if the ambient energy density is sufficient.

The W particle (which is nowadays readily produced in accelerators) is approximately 80 times heavier than the proton, which explains the relative "weakness" of the weak force - there is a huge energy barrier to surmount before weak interactions can occur. However, this also raises the obvious question of what this massive particle is composed of - certainly not ordinary matter, the stuff of baryons and leptons. My guess is that the IVBs generally are nothing other than a piece of very compact spacetime metric, similar to the dense metric of the early moments of the Big Bang. The huge mass energy of the particle is the binding energy required to compress the metric, perhaps fold it, and secure and quantize it in the particular configuration that characterizes the W, Z, or X. Hence these particles are perhaps similar to the compacted, topological, multidimensional particles of "string" theory. The hypothetical "Higgs" boson may also be a "metric" particle. (See details of the weak force transformation mechanism in [row 3, cell 3].) (See also: "[The Higgs Boson and the Weak Force IVBs] for a further discussion of the weak force in its full energy spectrum.)

The IVBs are an especially complex example of nature's penchant for quantization, and like other quantum processes, are responsible for a good deal of head-scratching. I can think of two reasons why the process of particle transformation should be quantized: 1) quantized units are indefinitely reproducible without loss of information or precision (Nature's "digital" information coding); 2) to ensure the charge invariance of the "hidden" or implicit lepton number charge (see below) - or in fact, any charge. (See: "[Global-Local Gauge Symmetries of the Weak Force].)

In the initial phase of particle creation, particle-antiparticle pairs, presumably of all types, are created but annihilate each other instantly, recreating the light energy from which they are made. So long as these pairs are created and annihilated in equal numbers, the symmetry of the light Universe is maintained. But there is an inherent asymmetry in the way the weak force interacts with matter vs antimatter, with the consequence that even though particle pairs are created symmetrically (via the electromagnetic force), they do not decay symmetrically (via the weak force). Most probably these asymmetric decays occur in neutral leptoquarks, heavy analogs of the neutron. An excess of matter is produced in this process, breaking the symmetry of the particle-antiparticle pairs and the light Universe, creating the matter comprising the Cosmos we see today. It is the consequence of this broken symmetry of light, manifesting as massive matter-only particles, their quantized charges, including time and gravitation, that we will trace in the remaining rows of the model.

Row 2 - Particles - Raw Energy Conservation

Row 2: "Down payment", "money up front", "pay now" - raw energy conservation. The major concepts of Row Two center on bound energy, mass, momentum, particles, time, gravitation, and inertial forces as raw energy debts, conserved states, or reactions occasioned by the conversion of light to matter in the Big Bang. The local, temporal, causal nature of matter vs the non-local, atemporal, and acausal nature of light is emphasized. The elementary particles of matter, the quarks and leptons, are examined.

With symmetry-breaking and the creation of matter from light during the "Big Bang", we pass from the initial global symmetry of light, space, and absolute motion, as "gauged" (regulated) by the universal electromagnetic constant "c", to the local asymmetry of matter, charge, time, and relative motion, as gauged by the universal gravitational constant, "G". A basic challenge posed to the forces of nature is to conserve energy and symmetry simultaneously in both free and bound forms of electromagnetic energy.

Mass or Bound Energy
(row 2, cell 1)

Einstein's most famous formula, $E = mcc$, expresses the notion that the energy stored in mass is enormous and somehow related to light through the electromagnetic gauge constant c. DeBroglie noted that Planck's formula for the energy of light $E = h\nu$ (where ν = the frequency of light, and h = Planck's constant) contained the same E; putting the two together, DeBroglie wrote $h\nu = mcc$, expressing the conversion of free energy to its bound form (or vice versa). This equation implies that all the energy of light is conserved in massive form in such a transformation.

We might think with some justification that energy conservation is satisfied by DeBroglie's equation and nothing more need be said. But this is just "raw" or total energy conservation, conservation of quantity, not quality. The conservation of the quality, or symmetry, of free energy has not been addressed by this formula, nor has the conservation of light's entropy. No massive particle can be created from free energy without engendering a symmetry (and entropy) debt and charge of some sort. If the free energy is simply absorbed by an existing massive system (for example, the absorption of a photon by the electron shell of an atom) without the creation of a new charged particle, then at least a gravitational (= entropy) charge will be recorded.

Whenever we encounter the intrinsic dimensional motions of "velocity c" (light), "velocity T" (time), or "velocity G" (gravity), we are dealing with the entropy drives of free and bound energy in their primordial or primary forms. At its most basic level, the gravitational charge represents the transferal, conversion, and conservation of the spatial entropy drive of free energy (light) to the temporal entropy drive of bound energy (matter) (in the case of gravity a symmetry debt is always combined with the entropy drive). Free energy cannot be transferred to bound energy (or vice versa) without also transferring, converting, or conserving the primordial entropy drive of that energy; in massive particles, the intrinsic motion of time is the primordial entropy drive of the system. Time is created by the gravitational (or quantum mechanical) conversion of space and the drive of spatial entropy to time and the drive of historical entropy (see: "Entropy, Gravitation, and Thermodynamics"). Hence we must include time, the primordial entropy drive of bound energy, along with gravitation in Row Two, keeping in mind, however, that gravitation has in addition to its entropy conservation role a symmetry conservation role which also links it to the charges and discussion of Row Three.

The basic function of mass and momentum is apparently the compaction ("packaging") and storage of free energy, and the conversion of light to a bound energy form with a less destructive entropy drive, as touched upon in the discussion of Row One. We also took note of the role of gravitation as a supplier of negative energy in the creation of matter during the "Big Bang". Mass is bound electromagnetic energy, and it is

asymmetric in many ways by comparison to the free electromagnetic energy (light) from which it is created. For this reason mass carries various charges, which are symmetry debts whose origins we have traced to the conservation of light's perfect symmetry (see Row 3). The most fundamental symmetry debt of mass is dimensional - mass is 4-dimensional, with no (net) intrinsic spatial motion, but with a time dimension which moves instead. Because time exists (among other reasons) to establish and control causality, the time dimension itself is necessarily one-way, hence asymmetric. Free energy, from which mass is formed, is a 2-dimensional transverse wave, whose intrinsic motion sweeps out a third spatial dimension. Four-dimensional massive matter or bound energy is local, temporal, and causal; two-dimensional massless light or free energy is non-local, atemporal, and acausal.

Time and Entropy
Time
(row 2, cell 2)

Time is a dimensional asymmetry, or dimensional symmetry debt carried by mass; time is also the primordial entropy drive and expression of entropy in matter: the intrinsic motion of time is the entropy drive of bound energy and history. Gravitation creates the time dimension of matter by annihilating space and extracting a metrically equivalent temporal residue. The gravitational field of bound energy is a remnant of the entropy drive or intrinsic motion of the free energy which originally created matter. Essentially, gravitation converts the intrinsic motion of free energy (as gauged by "velocity c") into its entropic analog and metric equivalent, the intrinsic motion of matter's time dimension (as gauged by "velocity T"). (See: "The Conversion of Space to Time".)

The intrinsic motion of light creates space and the intrinsic motion of gravity creates time. Time marches on to create history, the temporal analog of space. The intrinsic motion of light is the spatial entropy drive of free energy, and the intrinsic motion of time is the historical entropy drive of bound energy. Welded together by gravitation, the intrinsic motions of time and light create historic spacetime, the compound conservation domain of free and bound electromagnetic energy. Space and the drive of spatial entropy (S) are gravitationally transformed into time and the drive of historical entropy (T), a transformation which can be symbolically represented in a "concept equation" as:

$$-Gm(S) = (T)m$$
$$-Gm(S) - (T)m = 0$$

(See: ""A Description of Gravitation".)

Bound energy's most obvious asymmetry (matter's 4-dimensional energy state) is due to matter's lack of intrinsic spatial motion "c", meaning bound energy is "local" and associated with temporal causality chains. The 4-dimensional energy state of matter gives bound energy a different inertial status than free energy, because light is 2-dimensional. The "Interval" of free energy = 0 and light produces no gravitational field; bound energy has a real, positive Interval (because of its time dimension) and a gravitational field (also because of its time dimension). Both time and gravity are asymmetric dimensional attributes. I associate the gravitational charge ("location") with the primordial entropy drive of bound energy (the intrinsic motion of time), and with the broken symmetry of the universally equitable distribution of light's energy throughout space (light's symmetric "non-local" energy state or "zero Interval"). Both local time and local gravity vary in intensity with the quantity and density of matter, demonstrating their association with the local character of bound energy, and with the significant dimensional parameters of the asymmetric spacetime distribution of matter's immobile energy content, especially matter's location, quantity, and density.

When free energy is converted to bound energy, a portion of the entropy-energy driving the spatial expansion of the Universe is gravitationally converted to the entropy-energy driving the historical expansion

of the Universe; in the process, space is gravitationally annihilated, decelerating the spatial expansion accordingly. (See: "A Spacetime Map of the Universe".)

The gravitational conversion of space to time is physically demonstrated by black holes, and mathematically formulated in the Bekenstein-Hawking theory relating the surface area of a black hole to its entropy content. (See: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".)

Time also plays a crucial part in the symmetry conservation role of gravitation (as we will see below when we consider the "location" charge of gravity), providing the historical dimensional parameter within which charge conservation has meaning. (See: "The Double Conservation Role of Gravity".)

Charge Invariance

The invariance of charge in the service of symmetry conservation is another rationale for the tangential relationship between matter and matter's entropic conservation domain, historic spacetime. Matter, and matter's associated charges, exist only in the present moment of time, and do not participate in the entropic expansion of historic spacetime. The charges of matter, as well as the energy content of matter, are therefore protected from entropic enervation or dilution by the "march of time". Atoms simply do not age, and charge magnitudes are invariant through time. The tangential contact between matter and historic spacetime is also the reason for the weakness of gravity: gravity need supply matter with only enough temporal entropy to maintain or "service" the tiny tangential point of contact. At this point of contact, gravity is actually the same strength as the electromagnetic force - as the black hole demonstrates. This notion accords well with the observation of P. A. M. Dirac that the ratio of the strength of the gravitational force to the electromagnetic force is the same as the ratio of the radius of an electron to the radius of the Cosmos - the electron representing the physical size of the "tangential" point of contact between matter and historic spacetime.

Of course, Special Relativity also tells us that matter cannot move with the metric equivalent of "velocity c", and that therefore the time dimension must move instead, while matter remains stationary and rides the "time train". There are multiple reasons for matter's isolation in the "universal present moment", illustrating the seamless interweaving of all natural law, and raising again Einstein's question: is there any latitude in the construction of the Universe? From the perspective of the "Anthropic Principle" (natural law must allow human life), the answer is apparently "no".

Entropy

Entropy exists in several forms in nature, always with the same purpose, to prevent violations of energy conservation. Unless the context indicates otherwise, when I refer to "entropy" in these papers (especially in such phrases as "space and spatial entropy" or "time and temporal entropy"), I am referring to entropy in its most primordial or pure form, as the intrinsic motion of light "gauged" or regulated by "velocity c" (in the case of "spatial entropy"), or as the intrinsic motion of time "gauged" or regulated by "velocity T" (in the case of historical or "temporal entropy"). Of course, time is also ultimately "gauged" or regulated by "velocity c", since time is defined as the duration (measured by a clock) required by light to travel a given distance (measured by a meter stick). See: "Spatial vs Temporal Entropy".

The Dimensions
(See: "The Time Train".)

> The dimensions of spacetime are conservation/entropy domains, created by the entropic, "intrinsic" motions of free and bound electromagnetic energy (the intrinsic motion of light and the intrinsic motion of matter's time dimension). These domains function as arenas of action,

where energy in all its forms can be simultaneously used, transformed, but nevertheless conserved. This is the major connection between the 1st and 2nd laws of thermodynamics.

Bound energy (matter) requires a time dimension to establish and maintain causality, to provide an entropy drive, and to balance its energy accounts, because the energy contained in mass varies with its relative velocity, and relative velocity involves time. Light does not require a similar accommodation because light's absolute velocity is non-relative and invariant; light's energy varies not with velocity but with frequency. Time is one-way because raw energy conservation forces the continual updating of matter's energy accounts, from one instant to the next, protecting causality, the temporal sequence of cause and effect. The "local" character of matter requires a causal temporal linkage, whereas the "non-local" character of light does not. Causality itself requires the one-way character of time; energy conservation requires the presence and protection of causality and its associated temporal entropy drive in every system of bound energy.

The intrinsic motion of time ("velocity T") is the primordial entropy drive of bound energy, causing the aging and decay of matter and information, and creating and expanding history, the conservation domain of information and matter's "causal matrix". History is the temporal analog of space: "intrinsic motion T" and "intrinsic motion c" are metric equivalents. The entropy drives T and c both produce analogous dimensional conservation domains for their energy types, history for information (matter's "causal matrix"), space for light. Space connects light; time and causal history connects matter; gravity connects all. It is the energetic nature of light that requires a spatial entropic domain, whereas it is the causal nature of matter that requires an historic entropic domain. Gravitation (entropy drive "G") converts space into time and matter into light (as in the stars), producing the equilibrated joint dimensional conservation domain of historic spacetime, where both free and bound electromagnetic energy can interact and find their conservation needs satisfied.

Entropy is a necessary corollary of energy conservation, actually responsible for the creation of our dimensional experience of spacetime through the intrinsic (entropic) motions of light, time, and gravitation (the entropy drives or "gauges" c, T, G). (See: "The Tetrahedron Model" - also available at the end of this paper.)

The Interval

The "Interval" is Einstein's mathematical formulation of a quantity of spacetime that is invariant for all observers regardless of their motion, uniform or accelerated. It is the analog of the Pythagorean theorem in 4 dimensions. The "Interval" of light is zero, which means light is "non-local". This is the fundamental symmetry condition of light. Light could not create its spacetime conservation domain, perform its primordial entropy function, nor gauge its metric without the spatio-temporal symmetry of "non-locality". But the Interval of mass, or bound energy, is always some positive quantity greater than zero, and this is because the time dimension is necessarily explicit for immobile, local mass, for reasons of entropy, causality, and energy conservation we have considered above. Conversely, because light is missing both the X and the T dimensional parameters, light's position in 4 dimensional spacetime cannot be specified. The basic function of Einstein's "Interval" is to rescue causality in material systems from the shifting perspectives of Einstein's reference frames in relative motion.

This all makes sense when we think about space filled only with light - in such a domain there is no purely spatial Interval because there is nothing to distinguish one place or point from another - all is uniform and indistinguishable spatial, metric, and energetic symmetry. But enter mass with its inevitable companions, time, charge, and gravitation (the asymmetric "gang of four"), and immediately we can distinguish a point or place - here is the particle - more importantly, here is the gravitational field pointing to the particle's location from every other place in space (the influence of the field is universal in extent). The gravitational field organizes the formerly featureless space around the particle's center of mass. But one more thing is needed to pin down this location as absolutely unique: because the Universe is always moving, expanding

due to the spatial entropy drive of light's intrinsic motion, the time dimension is also required to specify which of an endless succession of moving locations (or evolving, cooling energy states) we are to consider.

Does Light Produce a Gravitational Field?

The positive "Interval" of mass represents a dimensional asymmetry because it is unique, distinguishable, and invariant for all observers. Light has no associated gravitational field because it has no Interval and no "location". Being non-local, light cannot provide a center for a gravitational field, and an uncentered gravitational field constitutes a violation of energy conservation (because of producing "net" motion and energy). Consequently, freely moving light cannot and does not produce a gravitational field. Light's zero Interval is precisely the symmetry condition necessary to prevent the formation of an explicit time dimension and its associated gravitational field. Light could hardly function as the metric gauge of spacetime if it were itself plagued by a metric-warping "location" charge and gravitational field. Finally, light has no time dimension nor the gravitational field which could produce one.

This is the basic conservation reason why the intrinsic motion of light - whatever its actual numerical value - must be the "velocity of non-locality", the symmetry gauge and entropy drive of free energy, the gauge of the metrical equivalence between time and space, effectively an infinite velocity within its spatial domain. Otherwise light would have a "location charge", a time dimension, and a gravitational field, and spacetime would immediately collapse into a black hole. (If light produced a gravitational field, the Universe would have been "still born" as a black hole; instead of a "Big Bang" there would have been a "Big Crunch". The fact that the scientific "establishment" believes that free light produces a gravitational field continues to be a major conceptual roadblock in their ongoing effort to unify gravitation with the other forces. This is a major, crucial, and (at least in principle) testable point of difference between the unification scenarios of the "Tetrahedron Model" and "establishment" physics.)

In fact, the recently announced "acceleration" of the cosmic expansion of spacetime (see, for example, *Sky and Telescope* March, 2005, pages 32-39) provides observational evidence favoring my view that light lacks a gravitational field. As mass is converted to light in stars and quasars, by quantum radiance and particle and proton decay (and by analogous conservation processes in "dark matter"), the total gravitational field of the Cosmos is reduced, resulting, over cosmic time, in the observed "acceleration". (See: "Dark Energy: Does Light Produce a Gravitational Field?".)

Symmetries of Light Conserved in Matter

In terms of conservation: in obedience to Noether's theorem, bound energy stores the symmetry of light as the conserved charges (and spin) of matter; in obedience to the first law of thermodynamics, bound energy stores the raw energy of light as the mass and momentum of matter; in obedience to the second law of thermodynamics, bound energy stores the spatial entropy drive of light as the gravitational field and temporal entropy drive of matter. Gravitation and time induce each other endlessly. Thus entropy produces the dimensional conservation domains of free energy (space - through the intrinsic motion of light), and of information and matter's "causal matrix" (historic spacetime - through the intrinsic motion of time and gravitation). This is the iron linkage between the first and second laws of thermodynamics. Noether's theorem is drawn into this "trinity" of natural law because velocity c is both the entropy drive and the symmetry gauge of free energy, and as a conservation consequence, gravitation is a symmetry as well as an entropy debt. (See: "The Double Conservation Role of Gravitation"). The gravitational entropy debt causes the creation of time from space, the deceleration of cosmic spatial expansion and the creation of historic spacetime; the gravitational symmetry debt actually reverses this process, causing the creation of stars, galaxies, and quasars, resulting in the "acceleration" of the cosmic spatial expansion as they convert bound energy to light.

The Mechanism of Gravitation

Time and space are both implicit in the description of the motion of an electromagnetic wave: "frequency" (time) multiplied by "wavelength" (space) = c, the velocity of light. In the quantum-mechanical creation of a time "charge", when an electromagnetic wave collapses or becomes "knotted", it switches from the spatial or "wavelength" character of a moving wave to the temporal or "frequency" character of a particle or stationary wave - like a coin flipping from heads to tails. It is reasonable to call this temporal expression a "charge" because time is asymmetric; being one-way, time has the asymmetric or informational character of any other isolated charge of matter. Time differs from the other charges in that it is an "entropic charge" - a charge with intrinsic dimensional motion. The asymmetric time charge produces a specific "location" in the otherwise symmetric field of space - giving the massive particle it is associated with a positive "Interval", whereas the light from which the particle was produced had a "zero" Interval. (See: "[Gravity Diagram No. 2](#)".)

This is the formal character of gravity's "location" charge - the positive Interval of bound energy breaks the non-local spatial symmetry of the free energy which created it. This non-local symmetry state had produced the equitable distribution of light's energy throughout space, a symmetry broken by the concentrated lump of immobile energy represented by bound energy's undistributed "rest mass". It is the distributional asymmetry of matter's energy content which is the origin of gravity's "location" charge. Demonstrating this point, the "location" or gravitational charge records the spacetime position, quantity, and density of the asymmetric energy distribution represented by any form of bound energy. Nor is gravity a passive signal: gravity will direct you to the center of this asymmetry by carrying you there bodily ("rubbing your nose" in it). Finally, gravity will repay the symmetry debt by converting bound to free energy in stars and quasars (partially), and via Hawking's "quantum radiance" of black holes (completely).

As magnetism is the invisible, "intrinsic", projective, "electro-motive" (electrically active) force of the loadstone, so gravity is the invisible, "intrinsic", projective, "inertio-motive" (dimensionally active) force of the ordinary rock. In the case of magnetism, we trace the force back to the moving (and aligned) electric charges of the atoms in the loadstone; in the case of gravity, we trace the force back to the moving (and one-way) temporal charges of bound energy in the rock. A moving electric charge creates a magnetic field; a moving temporal charge creates a gravitational field. In both cases the field is produced at right angles to the current. The relation is reciprocal as well: moving magnetic and spatial fields (gravity) create electric and temporal currents (time). This is the intuitive analogy between electromagnetism and gravitation which so intrigued Einstein. Finally, gravitation and time induce each other endlessly, as do the electric and magnetic components of light.

Extending the analogy, both time and magnetism are examples of "local gauge symmetry currents" associated with material systems in relative motion, which protect the invariance of "global" symmetries - velocity c, causality, and the Interval in the case of time ("Lorentz Invariance"), and electric charge invariance in the case of magnetism.

The "graviton" or field vector of the gravitational charge is a quantum unit of temporal entropy, a quantum unit of time, the transformed, "flipped", or inverted spatial entropy drive or intrinsic motion of the photon (implicit vs explicit time = photon vs graviton). Time is the active principle of gravity's "location" charge; time is the implicit entropy drive of free energy and the explicit entropy drive of bound energy; time is the connecting link between Quantum Mechanics and General Relativity. (See: "[The Conversion of Space to Time](#)".)

Quantum Mechanics and Gravitation

Gravitation is both a symmetry debt and an entropy debt, unique among the charges and their forces.

Gravity's double conservation role is due to the double gauge role of c, which gauges both the entropy drive and the non-local symmetry state of free energy. Gravity cannot conserve either gauge function of c without conserving both. This double nature is reflected in two different mechanisms, both of which convert space to time, one at the quantum level of charge - the entropy debt, and one at the macroscopic level of gravitational force - the symmetry debt. The two mechanisms are distinct but both are part of the gravitational conversion of space to time, connecting the quantum-mechanical aspect of gravitational charge (particle-charge-time-entropy) to the macroscopic aspect of gravitational flow (mass-location-space-symmetry). For a more extensive discussion of the mechanics of gravitation and the relationship between quantum mechanics and gravitation, see: "Entropy, Gravitation, and Thermodynamics"; and: "A Description of Gravitation".

Global vs Local Gauge Symmetry and the Gravitational Metric: Energy Conservation

The gravitational contribution to our 4x4 matrix or table at this position (row 2, cell 2) is the time dimension of bound energy. In the "global vs local gauge symmetry" interpretation of the cosmic order, the global symmetry state of reference in the case of gravity is the spatial symmetry state established by the electromagnetic constant "c" in row 1, cell 2, immediately above "time" in the matrix representation. Time is the compensating component of the local gauge symmetry "current" or field vector (the graviton or spacetime), derived from the global state by the gravitational annihilation of space and the extraction of a metrically equivalent temporal residue. The local state is derived from, imposed upon, and "warps" the global state, being an asymmetric derivative which introduces a one-way temporal and gravitational metric, both with a privileged or defined directionality ("forward" in time and "downward" in space). (See: "Global vs Local Gauge Symmetry in Gravity".)

The function of a dimensional metric is the conservation of energy. In the local, temporal metric established by gravitation (as gauged by the universal constant "G"), time is the new dimensional parameter which is required to conserve the energy accounts of matter, for at least four reasons: 1) the energy content of matter varies with matter's relative motion (whereas in the global, spatial metric, light's energy varies with frequency, not light's "absolute" motion); 2) providing the primordial entropy drive of matter (unlike light, matter has no (net) intrinsic spatial motion to supply its entropy drive); 3) to order the causality linkages of matter in the information domain of historic spacetime (whereas light is acausal, being both non-local and atemporal); 4) time provides the "local gauge symmetry current" which is necessary to compensate for the relative motion of material reference frames, protecting the invariance of the "Interval", causality, and velocity c (the "Lorentz Invariance" of Special Relativity).

Through the dimensional agency of time, energy conservation is accomplished in the local gravitational metric of relative motion and matter gauged by G, no less than in the global spatial metric of absolute motion and light gauged by c. The spherical symmetry of a gravitational field is crucial to its energy conservation role, not only to extract time from space, but to avoid imparting a spatial motion to the central mass. All gravitational fields of whatever strength are exactly symmetric (in their net effect), and vanish or self-annihilate at the center of the field where the temporal residue, the metric equivalent of the annihilated space, is extracted.

The temporal entropy drive of matter is provided at the expense of the spatial entropy drive of light. The expansion of history is funded by the expansion of space, resulting in the gravitational deceleration of the spatial expansion of the Cosmos. The energy for matter's expanding historical domain comes (via gravity) from the expansive energy of light's spatial domain. This conservation/symmetry circuit is completed by the gravitational conversion of bound to free energy in stars and related astrophysical processes, returning light to its spatial domain, reducing the total gravitational field of the Cosmos, and allowing the Universe to "accelerate" toward a gravity-free rate of spatial expansion.

The historical parameter of spacetime is a rationale for the long-range character of gravitation. Light is linked by space, matter is linked by time, causality, and history. Historic spacetime is the conservation domain of matter's causal information "matrix" or network, the "karmic" field of consequences, cause and effect, and historical connectivity. Today is the causal effect of yesterday, and yesterday must remain real in historic spacetime if the reality of our present moment is to be upheld. The material Universe is bound together by gravitation, historic spacetime, and temporal causality.

Quarks and Leptons

Mass assumes quantized, specific, particulate form as the strong force quarks and hadrons, and the weak force leptons. Hadrons are defined as particles containing quarks; hence all hadrons carry "color" charge, the source of the (quark-level) strong force. Leptons contain no quarks and hence carry no color charge. Leptons carry lepton "number" or "identity" charge, the source of the weak force. The leptons are true elementary particles whereas the quarks are sub-elementary. Electrons are familiar examples of the heavy members of the lepton family (electron, muon, tau, and (?) leptoquark); neutrinos are (nearly) massless members of the lepton family (there is a separate and distinct neutrino for each massive lepton). Protons and neutrons are familiar examples of the "hadron" family; they are further distinguished as members of the "baryon" class of hadrons, which are composed of 3 quarks. The only other hadrons are the mesons, which are composed of quark-antiquark pairs (see: "The Particle Table"). In general, the baryons function as mass carriers, and the leptons and mesons function as alternative charge carriers (as for example in the familiar electron-proton combination of atomic matter). Alternative charge carriers perform the crucial function of balancing charges of matter which otherwise would have to be balanced by antiparticles - which of course would cause annihilation reactions.

3 Elementary Families Each of 4 Particles
(row 2, cell 3)

The quarks and the leptons each occur in three "families" of differing energy levels; the quark and lepton families appear to be paired in these 3 families as follows (a precisely corresponding set of antiparticles exists but is not shown):

1) up, down (u, d) quarks and the electron and electron neutrino (e, ve);
2) strange, charm (s, c) quarks and the muon and muon neutrino (u, vu);
3) bottom, top (b, t) quarks and the tau and tau neutrino (t, vt).

There is no generally accepted explanation why there should be 3 energy levels of particles, why they occur in apparently correlated pairs, or how the quarks and leptons are related. Ordinary matter (including stars) is composed of the 1st family only. It seems likely that the quarks and leptons are both derived from a high energy, primordial "ancestor" particle, the "leptoquark"; it also seems likely that the 3 energy families of particles are in some sense reflecting their origin in the 3-dimensional metric structure of space. (See: "The Leptoquark Diagram"; and also: "The Hourglass Diagram".)

Quarks

In contrast to the "long-range" electrical and gravitational forces, which have an infinite range through spacetime, the strong force is a "short-range" force, an internal characteristic of nuclear matter. Quarks occur in only two kinds of particles: "baryons" composed of 3 quarks, and "mesons" composed of quark-antiquark pairs. Baryons are familiar to us as neutrons and protons, but there are many other 3 quark combinations possible using the heavier members of the quark family ("hyperons"). In addition, every quark combination seems to have many possible energetic expressions, or "resonances", just as electron orbits have many "excited" states. Typically, all excited states are exceedingly short-lived. Six quarks are known

in three "energy families"; the quarks are named "up, down"; "charm, strange"; and "top, bottom". Ordinary matter consists only of the up, down quarks in their unexcited or "ground" state (protons and neutrons). (See also: "The Short Range or Particle Forces"; and: "Synopsis of the Unification Theory: The System of Matter".)

All quarks carry a 1/2 unit of strictly conserved "spin", and a partial "flavor" ("number" or "identity") charge; quark "flavor" charges are not strictly conserved. However, the whole unit identity or number charge of the baryon is apparently strictly conserved, analogously to the strictly conserved number charges of the leptons. Quarks also carry partial electric charges (u, c, t quarks carry +2/3; d, s, b quarks carry -1/3), and fractional divisions of their distinguishing charge, color. There are three fractional color charges: red, green, yellow (not actually colors, just names of convenience), which are exchanged between quarks by the "gluon" field; each "gluon" is composed of a color-anticolor charge pair. One of the nine possible combinations of color-anticolor is doubly neutral ("green-antigreen"), leaving eight effective members of the gluon field. The constant "round-robin" exchange of the (massless) gluons from one quark to another (at velocity c) is the strong force mechanism which binds the quarks together.

At a higher level of strong force structural order and cohesion, a meson exchange field binds nucleons (protons and neutrons) into compound atomic nuclei. This higher-order or nucleon-level expression of the strong force (inter-baryonic rather than intra-baryonic) is essentially an "oscillation" of the nucleons between their possible neutron or proton identities (sometimes known as "isospin" or "isotropic spin" symmetry). "Isospin" symmetry amounts to an oscillation between quark up and down "flavors", whereas the lower order or gluon-level strong force amounts to an oscillation between quark red, green, and blue "colors" (leading in the gluon case to a symmetry known as "asymptotic freedom"). We will discuss strong force symmetry effects more extensively below and in row three.

The baryon is an incredible, miniature Universe of structure, information, charge, and activity. A large compound atomic nucleus is a swarming "hive", a veritable metropolis of quantum mechanical action and force exchange, all quite beneath our notice, due to the short-range character of the strong force (in both its "color" and "flavor" expressions). The essential miracle of matter resides within the massive bound energy system of the baryon, and its mysterious, high-energy origin within the early micro-moments of the "Big Bang". (See: "The Origin of Matter and Information".)

Being composed entirely of color-anticolor charges, the gluon field as a whole sums to zero, a crucial symmetry known as "asymptotic freedom" (Gross, Wilczek, and Politzer, 2004 Nobel prize). Quarks are permanently confined by gluons to meson or baryon combinations; they never occur alone or in any other combinations in nature. Finally, only quark combinations which sum to zero or unit (leptonic) electric charge, and neutral or "white" color charge, are allowed. Hence the quark-antiquark pairs composing mesons carry a single color and its corresponding anticolor (summing to "neutral" color), whereas in baryons the color charges of the gluon field pair with anticolors in all possible combinations (summing to "white" color).

Quarks are sub-elementary particles, as they carry electric charges which are fractions of the unit electric charge of the leptons, the only truly elementary particles. When one considers the properties of a baryon, it is hard to escape the impression that this is what a lepton would look like if it were somehow fractured into three parts. Since, by definition, you cannot "really" fracture an elementary particle, perhaps you could do so "virtually", provided the parts could never become "real" (individually separated), but remained forever united in combinations that sum to elementary leptonic charges. In this way, the fractured particle would still "look like" an elementary particle to the outside observer; nature is not above such tricks, as we have learned from the virtual particles and Heisenberg's "Uncertainty Principle". It seems probable that baryons are, in some sense, primordially "fractured" leptons. Such an origin (the "leptoquark") would go far toward explaining both the differences and the similarities of these two fundamental classes of particles. Just as the

baryon seems to be a fractured lepton, so the gluons seem to be a fractured photon ("sticky light") - the fractured field vector of a fractured electric charge. Hence the strong force gluon field appears to be a permanently confined derivative of the electromagnetic force, and both are strictly symmetric in all their interactions. (We will look at the strong force charges again in Row 3.)

Fermions and Bosons
(row 2, cell 4 - leptons)

Collectively, the hadrons and leptons, which comprise the material component of atomic matter (the nucleus, electron shell, and associated neutrinos), are known as "fermions". All fermions have a "spin", or quantized spin angular momentum, in 1/2 integer units of Planck's energy constant (1/2, 3/2, etc.); fermions obey the Pauli exclusion principle, which simply states that no two fermions can be in the same place at the same time, if all their quantum numbers are also the same. Fermions cannot pile up on top of one another indiscriminately; they keep their own counsel, which is why we get specific, discreet, sharp, and crystalline atomic structure rather than goo.

In contrast to the fermions is the class of energy forms known as "bosons", which includes the force carriers or field vectors of the 4 forces: the photons of electromagnetism (the quantum units of light), the gravitons of gravity, and the gluons of the strong force. As their name implies, the IVBs (Intermediate Vector Bosons) of the weak force have some characteristics of both classes, being very massive bosons. Together, the fermions and bosons comprise the particles and forces of matter. Bosons have whole integer spins (0, 1, 2, etc.) and they can and do superimpose or pile up on one another. Thus a photon or graviton can have any energy because it can be composed of an indefinite number of superimposed quanta, whereas an electron has a single, specific "rest mass" energy and charge. The bosons all bear some relationship to light and the metric, their probable common origin. Thus we have the photon (ordinary massless light), the graviton (inverted light), the gluon (divided or "sticky" light), and the IVBs (massive light). (See: "[The Higgs Boson and the Weak Force IVBs](#)".)

Once again we have a natural dichotomy which invites our curiosity, experiment, and speculation. What is the relationship between the quarks and leptons? They seem made for each other - are they indeed made from each other - perhaps both arising from a common ancestor?

I speculate that the ancestral particle of the quarks and leptons is the "leptoquark", the heaviest member of the leptonic elementary particle series. The leptoquark is a lepton at very high (primordial) energy densities, when its quarks are sufficiently compressed (by ambient pressure during the Big Bang) that its color charge vanishes through the principle of "asymptotic freedom". (The gluon field, being composed entirely of color-anticolor charges in all possible combinations, sums to zero when compressed to "leptonic size".) At lower energy densities, the quarks expand under their mutual quantum mechanical and electrical repulsion, causing the color charge to become explicit. The explicit (and conserved) color charge stabilizes the baryon, since neutrinos, which would otherwise cause its decay, do not carry color charge. Through the internal expansion of its 3 quarks, the leptoquark becomes a baryon, decaying eventually to the ground state proton, producing leptons and mesons (via the "W" IVB) along the way, which function as alternative charge carriers for the electric and identity charges of quarks and other leptons. (See: "[Introduction to the Weak Force](#)".)

Neutrinos

The neutrinos remain mysterious particles and are actively being researched. Whether or not neutrinos actually have mass is still a question. If neutrinos have mass, why is it so small, and how do they escape carrying an electric charge, as do all other massive particles? Is there a 4th "leptoquark" neutrino? What is the smallest possible natural mass quanta? Are neutrinos composite or elementary particles? Does the leptoquark neutrino exist and is it the source of "dark energy"? It is currently believed that neutrinos have a

very small mass and "oscillate" between their several possible identities, just as the massive leptons, whose identity charges are carried in "hidden" form, can change identities among themselves via reversible weak force decays (but only when mediated by the IVBs). (See: *Science*, Vol. 306, 26 Nov. 2004, page 1458.)

Neutrinos were thought to be massless leptons with intrinsic motion c. They are now thought to have a tiny mass and to move very nearly at velocity c because they are so energetic when formed. Neutrinos are the explicit form of lepton number ("identity") charge, which is "hidden" or implicit in the massive leptons (and probably also in the massive baryons and the leptoquark). Neutrinos, if they have any mass at all, are so light that they are apparently completely dominated by their deBroglie "matter waves". Hence in the particle-wave spectrum of energy forms, neutrinos are more wave than particle. (See: "deBroglie Matter Waves".)

Each massive lepton (electron, muon, tau, and (perhaps) the hypothetical leptoquark) is associated with a specific neutrino, or number charge, which I refer to as an "Identity" charge to acknowledge the symmetry debt carried by the weak force. All photons are indistinguishable one from another, but the leptons do not share this "symmetry of anonymity". While all electrons are identical, they are distinct from the photon, and from the other elementary particles - the muon, tau, and leptoquark. Neutrinos are the hallmark of an elementary particle; they are telling us that there are only three or four; all else is a composite (or, as in the case of the quarks, a subunit). Due to Noether's Theorem, the conservation domain requires this identity asymmetry to be recognized and accounted for, but nature is economical in its bookkeeping, concerning itself only with massive elementary particles. All neutrinos have left-handed spin, while all antineutrinos have right-handed spin, neatly distinguishing the leptonic series from its antimatter counterpart. Evidently, these specific "identity" charges function to facilitate annihilation reactions between matter and antimatter, allowing the various particle species to identify their proper "anti-mates". Through the facilitation of annihilation reactions (which must occur within the Heisenberg time limit for virtual reality), the identity charges make their proximate contribution to conserving light's symmetry. The neutrino's ultimate symmetry conservation role is to provide a physical embodiment for identity charge, which is conserved through time, can act as an alternative charge carrier for the identity symmetry debt, and is forever payable upon demand (via annihilation with the appropriate anti-identity charge). (See: "Identity Charge and the Weak Force".)

Neutrinos are quanta of information keeping the symmetry records of spacetime concerning the identity and number of all massive elementary particles within its domain. Combined with the metrical warpage of gravitation, we see that spacetime contains an actual structural "knowledge" of the location, mass, and identity of every elementary particle. This startling fact informs us that spacetime is as scrupulous concerning symmetry conservation as it is concerning raw energy conservation. We have already noted that historical spacetime contains a complete causal record (in the form of information) of all past events. In scientific terms, we are only beginning to appreciate how comprehensive is the meaning of the term "conservation domain" - a concept which the ancients understood in terms of "karma", the "Akashic Record", the continuing reality of the historical domain of ancestors, religious notions of the "afterlife", "heaven" and "hell", etc.

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