General Systems and the Unified Field Theory

(Part 1)
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John A. Gowan
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There is Nothing so Valuable as a Fresh Perspective

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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.

Introduction

(I recommend the reader consult the "preface" or "guide" to this paper, which may be found at "About the Papers: An Introduction" and the "Preface: The Sun Archetype". See also the related article: "Principles of the Unified Field Theory: A Tetrahedral Model" in which the 4 general conservation laws underlying the forces and charges of the field theory are discussed.)

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(The format of this paper ("row 1", "row 2", etc.) follows a 4x4 table which the reader should access and print for ready reference. 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". For a summary of the topic, see: "Synopsis of the System of Spacetime"; and "Synopsis of the System of Matter". See also an alternative form of the primary table: "A 4x4 Table of Conservation Law vs the Forces of Physics".

This paper presents a General Systems Model of the Unified Field Theory in a conceptual, non-mathematical form. The Unified Field Theory, Einstein's dream, is the essential cosmology of the rational, scientific mind. Science is a social effort, not the product of any one person, although it certainly has its luminous figures. Science is the product of a Civilization, with a history that stretches back at least 2500 years to its apparent origins in Greece.

We live in a time in which the cosmology of science is gaining ascendancy over the ancient, traditional, and intuitive cosmologies of religion - even the Pope has finally embraced Evolution, and the crimes of Galileo have long been forgiven. Although religions are also social phenomena, unlike science they tend strongly to be the product of a single profoundly intuitive mind, and to be centered upon the thought of that single individual - Moses, Buddha, Confucius, Lao-Tzu, Zoroaster, Christ, Mohammed, Joseph Smith, Mary Baker Eddy, Etc. Religion appeals to our intuitive and emotional nature, science to our rational and practical nature. Religions are also extremely conservative, tradition-bound, and resistant to change or new ideas; science by contrast is exploratory, experimental, and encourages change and new ideas.

Religious cosmologies are roundly criticized for being incapable of proof, and therefore subject to any kind of manipulation and interpretation. Scientific cosmologies are criticized for having nothing of significance to say about the human condition and the fundamental mysteries of life: Why are we here? What is the meaning and purpose of life? Of existence and the Universe? Is there life after death? Is there a God? Is there a spiritual realm or dimension? Do we have an immortal soul?

It is the unique character and purpose of General Systems to take a view which bridges religion and science, to see both these products of human thought as simply the intuitive vs rational discovery of a single natural pattern, the fractal algorithm or generative resonance of our Universe. A fractal is a repeating pattern, whose iterations generate both larger and smaller "self-similar" images or systems. A fractal is therefore the epitome of a General System. Resonance is a closely allied phenomenon, in that resonance can occur between similar patterns on different scales. For example, the notion that "man is created in the image and likeness of God" is a fractal (or resonant) notion, as is the venerable

adage "as above, so below". The phenomenon of resonance would therefore allow communication and exchanges of energy within any fractal system, including between man and God, and indeed between God and all of creation, providing a rationale for what is otherwise an outrageously presumptive assertion.

This great [Fractal Organization of Nature](#) I have roughed out to the level of my ability- experts in the various fields could carry it further. This pattern is in its essence a 4x3 iteration which usually fills out to a 4x4 due to the emergent properties associated with its complexity. You will notice from the table that I have divided the universal fractal into 5 realms, 3 physical and 2 metaphysical, the latter both perceptions of the human mind, which is not to deny their reality, but only to distinguish their type. I trace this pattern from its inception in the conservation laws, spacetime metric, and the original families of subatomic particles produced in the Creation Event or "Big Bang", to the nuclear and atomic levels, thence through organic molecular forms to DNA and the genetic code of all life. It continues on through the astrophysical realm in gravitation and the nucleosynthetic pathways of stars. Beyond these, we find it again in our own metaphysical formulations of divine principle and scientific law, the abstract order which stands in the shadow behind physical reality. (See also: ["The Information Pathway"](#).)

All five realms - twenty levels in all - have the same fundamental pattern. It is this universal natural pattern which our mind is apprehending through both its intuitive and rational faculties, individually and collectively, religiously and scientifically.

We are but one part of this grand fractal pattern of information and energy, but we are a very important part, for we represent the emergence of the self-awareness of the Universe, the attempt of the fractal to reflexively witness and experience itself. Just as we value our self-awareness, so the Universe values its own. It is in us and through us that the Universe awakes and begins to understand and appreciate itself. If we do not smell the rose, the Universe loses its chance to experience joy. Humans may be small in terms of size; but in terms of information content and our potential for complex experience, we are astronomical in magnitude and significance for the Universe.

It is generally believed that the physical sciences cannot address the fundamental questions of human life and its significance which traditionally have been the province of religion. I do not share this belief. While it is perfectly true that the job of science is to get the rational cosmology "right", without any reference to its intuitive counterparts, and "let the chips fall where they may", it is certainly not true that science has nothing to say about the fundamental questions. Everything in the Universe has something to say about the human condition, for we are part and parcel of this Universe, its product, its flesh and blood, its eyes and ears and thoughts. As Carl Sagan famously observed: "we are star-stuff contemplating our origins"

People embrace religion because it tells even the least of us that we are important and connected to the Universe. If there is a God, the Universe acquires greater significance and connectivity, and by extension, so does humanity. Science needs to pay attention to this simple lesson in psychology and tell people why they and the Universe have significance. Humans will never trade a sense of personal significance for "scientific" knowledge - rather, knowledge must lead to an appreciation of every person's value, and to an understanding of humanity's connection to, and unique place and importance in, the Solar System, Galaxy, and Universe.

General Systems provides a methodology which allows us to look at the great body of scientific work - now available for the first time in the history of our species - relate it directly to our intuitive, religious cosmologies, and vice versa, extracting from this comparison a common language which can speak meaningfully to us about our place in the Universe and the significance of our lives, in

"scientific" as well as in "religious" terms.

The Unified Field Theory is the rational, scientific counterpart of intuitive conceptions of Divine Order, invoking physical rather than spiritual principles to generate the material Universe. As the fundamental note of the entire resonant system, the unified field theory should fit the fractal pattern just as neatly as any of its harmonic iterations (the various levels), and since 1977 (the year I turned 40), I have struggled with the scientific (and popular) literature to discover this fit. I am at last personally satisfied that I have found the correct, general conceptual features of this fit, which you will find in the "Unified Field General System Table". (See also the "Hourglass" or "Grail" Diagrams" and the "Tetrahedron" models.)

The four forces of physics of course exactly fit the 4x4 pattern horizontally (see table). Vertically, I have listed the four principle energy states of our physical reality: free energy, bound energy, charges, and force fields. The logic is that free energy (light) produces particles (matter) which bear charges (the symmetry debts of light); the charges produce force fields (demands for payment) which act to return the system to its original symmetric form (light), paying the symmetry debts conserved by the charges.

The Unified Field Table

Let's consider the physical aspects of the table first and then move on to its general system properties. First we note that the table accommodates all the conventional fields, particles, charges, and forces of physics; there is a place for them all, and the simple act of organizing this data is in itself useful, just as the organized data of the Periodic Table of the Elements is useful. Like the Periodic Table, this is no random organization; the order is congruent with the General System pattern of all the other cosmological systems and physical realms modeled in the "Hierarchy" table. Finally, the order tells a story, the physical story of the creation of matter, the conservation of energy and symmetry, and the evolutionary "redemption" of the Universe (the return of bound energy to light's original symmetry).

(For those unfamiliar with the concept of conservation: conservation refers to any quantity which is invariant, which does not change, during a transformation. A familiar example is "number" in arithmetic. "Number" is conserved. Hence 2 + 2 always = 4, because number is conserved. If you think of the numbers 1 - 100 as the pennies of a dollar, then anytime you get change for a dollar you expect conservation to be observed in both our number and monetary systems during the transformation. Mathematics is a useful symbolic system for a quantitative description of nature primarily because it provides us with an abstractly conserved system (of numbers and operations) which can represent and model a physically conserved system (of energy and forces).

Row 1 - Symmetric Energy States and the "Creation Event" ("Big Bang")

(See also: "The Higgs Boson and the Weak Force IVBs" and "The Origin of Matter and Information")

Light and the Metric of Space

In row 1 (see table) I list the symmetric forms of free energy, and the breaking of their symmetry, during the "Creation Event" - the "Big Bang". The Universe begins as light - free electromagnetic energy - which is a perfectly symmetric energy form. Light is massless and carries no charges of any kind, produces no gravitational field, and has no time dimension in the ordinary sense. Light's intrinsic

motion c is a symmetry condition formally characterized by Einstein as its zero "Interval", which is a condition of "non-locality", and consequently "acausality" (lacking both place and time). The negative energy of gravity balances the positive energy of any bound energy forms which may exist during the "Big Bang". The creation of the Universe requires no net energy (or charge), and may be initiated as a quantum fluctuation of the "Multiverse" or the a-dimensional "vacuum".

Space is the conservation/entropy domain of light, created for its own conservation by the intrinsic motion of light (as gauged by "velocity c"). The potential existence of both space and time in light is implicit in the formulation of light's intrinsic motion - frequency (time) multiplied by wavelength (space) = c, the electromagnetic constant or "velocity of light". However, before the creation of matter the concept of time can only be applied globally to the Universe as a whole in the sense of its rate of entropic expansion and cooling, not locally to its parts, as we do today (before the creation of matter there are no "parts"). Einstein teaches us that before the creation of matter, there is only one clock, the Universe (effectively, its temperature); after the creation of matter, every particle carries its own timepiece, whose rate depends upon its relative motion and gravitational environment. Spacetime is actually a compound dimensional conservation/entropy domain (for free and bound electromagnetic energy) created by the interaction of matter and gravitation with light and space.

The zero Interval and "non-local" character of light means that light, in its own reference frame, is everywhere throughout space simultaneously - a symmetry condition with respect to the distribution of light's energy within its conservation domain ("symmetry" refers to a condition of balance, sameness, or equality). The electromagnetic constant c is the "gauge" or regulatory standard for the metric of spacetime, the fixed relationship which establishes the equivalence of measurement between the dimensions: 300,000 km of linear space is metrically equivalent to 1 second of temporal duration. At c this equivalence is complete and time is suppressed to a locally implicit state (light's "clock is stopped"). The suppression of the asymmetric time dimension (and time's inevitable companions, charge, mass, and gravitation) is the principle symmetry-keeping function of c. (See: "The Conversion of Space to Time".)

In a universe of pure light, before the creation of matter, 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, indeed the very reason for its existence, as it is the regulatory mechanism which performs the conservation functions of the domain (energy, symmetry, entropy), controlling and coordinating the rate of expansion and cooling of space both globally and locally. The entropy of light is expressed through its intrinsic motion; but it is also light's intrinsic motion which creates light's spatial conservation domain, while simultaneously maintaining metric symmetry (including the suppression of time), and causing the expansion and cooling of space. Therefore light and space are related as the first and second laws of thermodynamics. It is the function of entropy to create a dimensional conservation domain in which energy can be used, transformed, but nevertheless conserved. Without entropy, energy conservation would not allow the Universe to spend its energy capital; without symmetry, energy could not be conserved within the spatial metric.

Our physical universe, including the conservation domain of space, 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 light is the only energy form which can create its own conservation domain (space) from nothing (or rather, from its own intrinsic motion) - matter must create its time dimension and historic causal domain from preexisting space, via gravity. Light is the energy from which all other energy forms are made, and to which they all reduce and return. (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, 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. The theorem does not say exactly how this must be done, but in practice the symmetry of light is conserved through the charges (and spin) of matter - charge conservation = symmetry conservation - and the symmetry of the metric field of spacetime is conserved through inertial and gravitational forces.

I think of Noether's theorem as the "Truth and Beauty" theorem, in reference to Keats' 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.

Noether's theorem tells us why all the forces of nature are 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 former state of perfect symmetry. *The charges of matter are the symmetry debts of light*. These charges produce forces which act to return the system of matter to its original symmetric form, light.

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 respective origins as specific symmetries of light, accomplishing our conceptual unification. Matter is but an asymmetric form of light; the charges and forces of matter act to return bound energy to its symmetric, original state of free energy. In the pages which follow, we will follow out this simple program of force unification, by identifying the broken symmetries of light represented by the conserved charges of matter (including gravitation).

This is a conceptual unification only, in terms of general principles of conservation law. Almost no mathematics is involved. The disadvantage is that no quantitative calculations can be performed from such a unification scenario (although many may suggest themselves); the advantage is that most people can understand it. The great difficulty with modern science is that although it intends to produce a rational cosmology to replace the ancient intuitive "world systems", almost no one can understand either the terminology or the mathematics involved. Modern science has succeeded in disenfranchising the public from modern cosmology, and in so doing has produced a backlash of resentment in which traditional religions and mythologies are being embraced with renewed emotion and enthusiasm. Whether "ancient wisdom" or "new age religion", the public can at least understand and feel a personal connection to the intuitive cosmological order, and this is why a General Systems bridge between these perspectives is so important. The bridge can be produced in English, in terms of a few conservation laws (including simple diagrams), and almost anyone who wishes can understand it.

Particles

Matter consists of two types of massive particles: 1) elementary particles with no internal parts, called leptons; 2) 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 or "nucleons" (protons and neutrons), examples of the hadron family. Hadrons containing a quark-antiquark pair are known as mesons, while hadrons containing 3 quarks are called baryons; no other stable quark combinations exist in nature (see: "The Particle Table").

Together, the energy of light and the structure of metric space have the capacity to produce particles, which are essentially a "packaging" of light's free energy. The mechanism by which this transformation of wave to particle 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, this "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 higher energy densities, and similarly, the spectrum of composite particles (baryons), which can store additional energy internally, as if they contained an internal set of compressible springs (the mutually repulsive forces between quarks). (The ability to form electrically neutral quark combinations (as in the neutron) is another and more compelling "reason" for the composite nature of baryons). 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". Another good "reason" (from the anthropic point of view) for the initial conversion of light to matter, is to rescue at least some of the Universe's energy from the vitiating entropy drive of light's intrinsic motion, as gauged by "velocity c". This is because the quiescent entropy drive of mass (the intrinsic motion of time) does not attack matter's useful energy content in any significant way. (See: "The Time Train".)

I presume there is a physical correspondence and relationship between the metric of space and the structure of particles (the beginning of the universal fractal resonance). Light exists as a 2-dimensional energetic vibration of the metric structure of space; the intrinsic motion of light "sweeps out" a third spatial dimension. The metric is a conservation structure associated with light and light's intrinsic motion, created by light for its own conservation. Usually this vibration is simply transmitted within the metric structure 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 its own metric and tie itself into higher dimensional "knots", which cannot be transmitted at c because they are no longer 2-dimensional. Such "knots" comprise particle-antiparticle pairs, and their structure, energy, and information content is derived from the mixture of metric space and light. 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 connection between energy, the metric, and the structure of particles is currently being investigated by "string" theory (see Brian Greene's "The Elegant Universe").

Four-dimensional "knots" will contain an asymmetric dimension, time, which is presumably the source of the weak force asymmetry in its matter-antimatter interactions. Just how leptonic "knots" differ from quark "knots" (dimensionally? topologically? symmetrically?) remains a mystery. Nevertheless, deriving both from the same spatial (or spacetime) metric provides an essential conceptual basis for understanding their relationship. The further value of such theoretical notions is that they provide a direct connection between light, spacetime, and matter, a connection which is

evident in other physical phenomena, such as the interchangeability of light and matter in the creation and annihilation of particle-antiparticle pairs, Einstein's and Debroglie's mass-energy and particle-wave relations ($h\nu = mcc$), the gravitational and electromagnetic fields associated with massive particles, etc.

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 particle (the "leptoquark") which "fractured" under the high pressure of the "Big Bang" and so could store more energy, and assume an electrically neutral internal configuration of its quarks. 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 (or to "leptonic size" - by the ambient pressure of the Big Bang, a black hole, or the "X" Intermediate Vector Boson (IVB)), the color charge of the gluon field sums to zero (see row 4, "Gluons"), 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 antineutrino and the "X" IVB, a particle we examine in the following section (this is also the weak force pathway of "proton decay"). (See: "The Origin of Matter and Information".)

Symmetry-Breaking and the Weak Force

Leptons and Mesons as Alternative Charge Carriers

The lepton and meson fields function as alternative charge carriers for the massive quark field of the baryons. Without these alternative charge carriers (electrons carry electric charge, neutrinos carry number or "identity" charge, mesons carry quark flavor, spin, color, and partial electric charges), the baryon field would remain locked in mutually annihilating (symmetric) particle-antiparticle pairs. Hence we see that in order to produce an asymmetric, isolated particle of matter (a "singlet") from a symmetric particle-antiparticle hadron pair, we require: 1) the primary mass-carrying field (the quarks, composite baryons, electrically neutral leptoquarks); 2) a secondary field of alternative charge carriers (electrons, neutrinos, 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) in practice, we find a third field is required, the weak force "Intermediate Vector Bosons" (IVBs - including the Higgs boson), which mediate and broker transformations between and within the mass carrying field of the baryons and the alternative charge carrying fields of the leptons and mesons (see below); 5) a final requirement is that there exist some fundamental basis of similarity between the mass and charge carrying fields if they are to interact at all - they must be able to recognize 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, electron, or IVB. (See: "The Origin of Matter and Information".)

Obviously, the relationship between the quark and lepton fields 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 primordial symmetry of free electromagnetic energy (light) and its particle-antiparticle form.

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 include in this group the hypothetical "X" particle responsible for producing leptoquark and proton decay, as well as several Higgs bosons). (See also : "The Higgs Boson and the Weak Force IVBs".)

The weak force is the asymmetric physical mechanism that produces elementary massive particles from light during the initial moments of the "Big Bang", and continues in today's Universe to govern the creation and destruction of elementary particles, including transformations of flavor, number, or identity charge among quarks as well as leptons. Only 3 massive leptonic elementary particles are known, the electron, muon, and tau, identical in all their properties other than mass and "identity" 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. The hypothetical 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: 1) to regulate the creation and destruction of the leptonic series through interactions with the symmetric vacuum "sea" of virtual particle-antiparticle pairs (the "X" IVB family produces leptoquarks and baryons, the "W" IVB family produces leptons and mesons); 2) govern the transformations and decays of elementary particles, quarks as well as leptons, via the "W". The "Z" mediates neutral weak force interactions in which particles (typically neutrinos) simply scatter ("bounce") or swap identities.

What is most remarkable about the IVBs is that they seem to be reaction processes cast in quantized, massive, particle form. These are not particles like the leptons and baryons which form stable matter; they are "metric" particles of interaction, catalysts of transformation present only when mediating a reaction, "virtual" particles usually known only by their effects, existing within the "Heisenberg Interval" of virtual reality, but real enough and producible if the ambient energy density is sufficient.

The IVBs are the most complex example of nature's penchant for quantization that we know of, and like many quantum processes, are responsible for a good deal of head-scratching. I can think of three reasons why this process should be quantized: 1) quantized units are indefinitely reproducible without loss of information or precision (Nature's "digital" information coding); 2) to protect the invariance of weak force charge magnitudes ("identity" charge); 3) how otherwise could the asymmetry of the weak force be built into its structure?

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 this particle (and the IVBs generally) are nothing less than a fragment of very compact spacetime metric, similar to the energy-dense metric of the early moments of the Big Bang. The huge mass energy of the particle is the binding energy required to compact the metric, perhaps fold it, and secure it in the particular configuration of the W, Z, or X. Hence these particles may be analogous to the compacted, topological, multidimensional particles of "string theory".

While this is pure speculation, the notion has several advantages. First, it offers a mechanical explanation for the reactions mediated (catalyzed) by this particle. The dense metric of the W simply functions to bring the reactants of a weak force process into such close proximity that they can exchange charges in full satisfaction of the conservation laws, which they cannot do when separated by ordinary distances. Typically this will involve a particle-antiparticle pair drawn from the virtual particle "sea", as well as the reacting particle itself. For examples of these types of reactions, see: "The Particle Table" and "The 'W' IVB and the Weak force Mechanism" (pdf) (an HTML version of this

paper is also available).

The most significant feature of the massive IVBs is that they recreate the original conditions of the energy-dense primordial metric in which particles were first created and transformed during the early micro-moments of the "Big Bang". This recapitulation (of the *electroweak force unification era,* or symmetric energy state) ensures that the original and invariant values of charge, mass, and energy are handed on to the next generation of elementary particles. The IVB mass not only provides a "safe house" where charge and energy transfers can take place, it simultaneously ensures that the appropriate alternative charge carriers are present. Elementary particles created today must be the same in all respects as those created eons ago during the "Big Bang".

There is a crucial difference between the creation of particles via electromagnetic particle-antiparticle pair formation, and the weak force transformation of existing particles to other elementary forms. In the case of particle-antiparticle pair creation, there can be no question of the suitability of the partner for a subsequent annihilation reaction which will conserve symmetry. However, in the case of the transformation of an existing elementary particle to another form, alternative charge carriers must be used, since actual antiparticles can only produce annihilations. But how is the weak force to guarantee that the alternative charge carriers - which may be a meson, a neutrino, or a massive lepton - will have the correct charge in kind and magnitude to conserve symmetry at some future date in some future reaction, or with an unknown partner which is not its antiparticle? Furthermore, the quark charges are both partial and hidden (because they are "confined"), and the number charges of the massive leptons and baryons are also hidden (because they are "implicit") - they have no long-range projection (such as the magnetic field of electric charge) to indicate to a potential reaction partner the relative condition of their energy state.

These conservation problems are all solved by a return to the original conditions in which elementary particles and their transformations were first produced, much as we return and refer to the Bureau of Standards when we need to recalibrate our instruments. The necessity for charge and mass invariance in the service of symmetry and energy conservation therefore offers a plausible explanation for the otherwise enigmatic large mass of the weak force IVBs. The IVB mass (as scaled or "gauged" by the Higgs boson) serves to recreate the original environmental conditions - metric and energetic - in which the reactions the IVBs now mediate first took place, ensuring charge and mass invariance and hence symmetry and energy conservation, regardless of the type of alternative charge carrier that may be required, or when or where these transformations take place. (See: Global-Local Gauge Symmetries of the Weak Force.)

We should also note that all particle creation and transformation processes, whether electromagnetic or weak, involve (at some stage) virtual particles drawn from the vacuum "sea". The mass, charge, and all other conserved parameters of virtual particles are gauged and regulated by universal constants of electromagnetism and the metric - c, e, h, etc. - which also ensures the uniformity of any elementary particles produced from this common source.

While the details of the weak force mechanism remain to be clarified by experiment, the general picture is clear. There is a specific, primordial mechanism for transforming light into its particle form, a mechanism which utilizes the IVBs (and the Higgs boson scalar) of the weak force. This mechanism produces the leptonic spectrum of elementary particles during the initial moments of the Big Bang (and precisely reproduces it at all later times). This particle spectrum includes the leptoquark as its heaviest and highest energy member (produced by the "X", or simply by the ambient pressure of the Big Bang); the leptoquark is the first particle actually isolated by the asymmetric action of the weak force during the Big Bang. Subsequently, the leptoquark expands to become a heavy baryon ("hyperon"), and then decays (via the "W" IVB) to produce the lower energy (lighter) baryons,

mesons, and leptons.

Space is the conservation domain of light. As such, the metric is very particular about what happens to its free energy content, and strictly regulates the transformation of symmetric light to asymmetric bound forms. The weak force is the guardian of the transformation process - all candidates for transformation must pass through its gates, stop at its checkpoint, receive "identity" tags (charges) and quantized forms - and just those whose "identities" spacetime is prepared to conserve (via neutrinos), no others. The weak force mechanism is nothing less than a border crossing, requiring passports - "Checkpoint Charlie". Once these conservation formalities have been observed and particles have received their "identity" tags, the particles are free to pass through the boundary between the 2-dimensional, spatial conservation domain of light, and enter the 4-dimensional combined conservation domain of mass and light (spacetime), where they must obey new laws of energy, entropy, and symmetry conservation. The "identity" charges are necessary to ensure the particle's ultimate conservation and retrieval from the 4-D conservation domain of spacetime. (For a further discussion of the weak force in its full energy spectrum, see: "The Higgs Boson and the Weak Force IVBs".)

In the initial phase of particle creation, particle-antiparticle pairs, presumably of all types, are created and annihilate each other instantly, recreating the light energy from which they were 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, they do not decay symmetrically. Most probably these asymmetric decays occur in neutral leptoquarks, heavy analogs of the neutron. An excess of matter is produced in this process (of about one part per ten billion), breaking the symmetry of the particle-antiparticle pairs and the light universe, creating the matter comprising the universe we see today. For a discussion of these reactions, see: "The Formation of Matter and the Origin of Information".

The first row of our 4x4 matrix, through symmetry-breaking and the creation of matter, has set the stage for the evolution of the Universe and the remainder of our story. Rows two and three discuss conservation reactions by spacetime to the creation of massive particles; the fourth row concerns the return of the material system to symmetry and light. The system of light and space has been degraded from its initial symmetry by the creation of atoms, and it is here that the story becomes of special interest for bound energy forms such as ourselves. (For a diagram and discussion of the general principles underlying the theory, see: "The Cosmic Tetrahedron" and its "Explanatory Text".) (For a conceptual synthesis of the tetrahedron model with the more formal "Standard Model" of "establishment" physics, see: "Global-Local Gauge Symmetries in the Tetrahedron Model"; see also: "The 'Tetrahedron Model' vs the 'Standard Model' of Physics: A Comparison".)

Row 2 - Particles - Raw Energy Conservation

Mass: E = hv; E = mcc; hv = mcc

This is the row of bound energy: conservation of light's raw energy in terms of massive particles, momentum, etc. 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 constant c. DeBroglie noted that Planck's formula for the energy of light: E = hv (where v = the frequency of light, and h = Planck's constant) contained the same E and wrote hv = mcc, expressing the equivalence between free energy and its bound form. This equation states that all the energy of light is conserved in massive form in this 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. No massive particle can be created from free energy without engendering a symmetry (and/or entropy) debt and a corresponding charge of some sort. Even if free energy is simply absorbed by an existing massive system without the creation of a new charged particle (for example, the absorption of a photon by the electron shell of an atom), then at least a gravitational symmetry (and entropy) debt will be recorded by the "location" charge of gravitation. The same is true for changes in the momentum of massive systems. Time is the entropy drive of massive systems, and time is created by the gravitational annihilation and transformation of space. (See: "Entropy, Gravitation, and Thermodynamics".)

The basic function of mass and momentum is apparently the compaction ("packaging") and storage of free energy as touched upon in the discussion of row one (although the conversion from spatial entropy to temporal entropy is perhaps of even more fundamental importance - see: "Proton Decay and the "Heat Death" of the Universe"). Mass is bound energy, and it is asymmetric in many ways by comparison to free energy. For this reason mass carries various charges, which are conserved symmetry debts whose origin we have traced to the perfect symmetry of light (see row 3 below). The most fundamental symmetry debt of mass is dimensional - mass is 4-dimensional, having a time dimension. The time dimension itself is of course asymmetric, being one-way. Free energy (light), from which mass is formed, is a 2-dimensional transverse wave, whose intrinsic motion sweeps out a third spatial dimension. As Einstein discovered, light has no time dimension, and no spatial dimension in the direction of propagation.

Linked to bound energy's most obvious asymmetry (time), is matter's lack of intrinsic spatial motion c. This attribute gives bound energy a different inertial status than free energy, because bound energy has a different dimensionality than free energy. The "Interval" of free energy = 0, but bound energy has a real, positive Interval and a gravitational field; both are asymmetric dimensional attributes. We associate electric charge with the dimensional asymmetry of time, and the gravitational charge with the positive Interval of bound energy. The fact that time is involved in the symmetry debts of both electric charge and gravitation complicates the distinction between these two very different charges. The electric charge acts to prevent the formation of time, charge, mass, and gravitation (via particle-antiparticle annihilation reactions); gravitation is a dimensional conservation reaction to the failure of electric charge to prevent the formation of bound energy, and in particular, to the explicit appearance of time. However, gravity does not act to prevent bound energy's formation, but after the fact, patiently goes about repairing the damage to light's symmetry.

Finally, the entropy drive of light (or free electromagnetic energy) is expressed as light's intrinsic motion in space. The entropy drive of matter (or bound electromagnetic energy) is time, created by the gravitational field of mass. Gravity converts space and the drive of spatial entropy (the intrinsic motion of light), to time and the drive of historical entropy (the intrinsic motion of time), converting the expansive principle of space to its metric and entropic equivalent, the expansive principle of history. Quite unlike electric charge (or any other charge), gravity carries an entropy debt as well as a symmetry debt. Time and entropy-energy is the monopolar, (one-way) active principle of the gravitational "location" charge, whose field vector is spacetime itself. The active principle of the dipolar electric charge is symmetry-energy, and its field vector is the photon. (See: "The Conversion of Space to Time".)

Time and Entropy - Causality and History

Note to Readers Concerning "Entropy":

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 historical 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" (expanding and cooling the spatial Cosmos in the case of "spatial entropy"), or as the intrinsic motion of time "gauged" or regulated by "velocity T" (expanding and aging the historic Cosmos in the case of "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 Interval - Local vs Non-Local Energy Forms

I begin this section by pasting in part of a paragraph from page 253 in my late father's book: "Trance, Art, Creativity", which presents a marvelous mathematical insight into the nature of the time dimension, by way of Einstein's formula for the "Interval":

> "Analysis of this equation [the "Interval"] provides us with the proportion that time is to space as "i" (the square root of -1) is to 1. Now "i" multiplied by itself is -1, so that in a metaphoric sense we can say that the time dimension is "half" a space dimension. Curiously one finds this out intuitively. We have full intuition of the three spatial dimensions, but we cannot intuit the fourth dimension, so we experience it as "time." Furthermore this experience is not full; it is partial, for we are on a one-way street indicated by "time's arrow" which allows us always to experience duration as getting later and later, but never the opposite."

(The book "Trance, Art, Creativity" is linked to and can be accessed in its entirety from my homepage).

The "Interval" is Einstein's mathematical formulation of a quantity of spacetime that is invariant for all observers regardless of their relative 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"; the "zero Interval of light" is Einstein's mathematical statement of the fundamental symmetry state of light. Light could not create its spacetime conservation domain, nor gauge the metric of an expanding universe, without the 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 mass, for reasons of energy conservation, entropy, and causality we have considered above. The basic function of Einstein's "Interval" is to rescue causality from the shifting perspectives of Einstein's moving reference frames. The invariance of the "Interval", causality, and "velocity c" ("Lorentz Invariance") is the metric equivalent of the invariance of particle charge.

This all makes sense when we think about space filled only with light - in such a space there is no purely spatial Interval because there is nothing to distinguish one place or point from another - all is uniform, indistinguishable, spatial and energetic symmetry. But enter mass and with it its inevitable companions, time, charge, and gravitation, and immediately we can distinguish a point or place - here is the particle - more significantly, here is the gravitational field pointing to the particle's location from every other place in space (the influence of the gravitational field is universal in extent). But one more thing is needed to pin down this location as absolutely unique: because the universe is always moving, either expanding or contracting (due to entropy), the time dimension is also required to specify which of an endless succession of moving locations in space we are to consider. Gravity provides matter with a time dimension as well as a spatial location - time is the active principle of gravity's "location" charge, and time is also produced and continuously replaced and renewed by the

gravitational annihilation and transformation of space. (See: " A Description of Gravitation".)

The positive "Interval" of mass is not just a mathematical abstraction of geometry; it is a dimensional, energetic reality defined by gravitation and time. The positive Interval, therefore, represents a dimensional asymmetry because it is unique, distinguishable, and invariant for all observers. Light has no associated gravitational field because it has no "location"; its zero Interval is precisely the symmetry condition necessary to prevent the formation of an explicit time dimension and a 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.

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 metric 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 at the Creation Event; instead of a "Big Bang" there would have been a "Big Crunch". The fact that the scientific "establishment" believes that light in free flight produces a gravitational field continues to be a major conceptual roadblock in their ongoing effort to formally (mathematically) unify the forces.) (See: "Does Light Produce a Gravitational Field?")

In terms of conservation: 1) in obedience to Noether's theorem, bound energy stores the (broken) symmetry of light as the conserved charges (and spin) of matter; 2) spacetime obeys Noether's Theorem through the inertial (and gravitational) forces of the metric; 3) in obedience to the first law of thermodynamics, bound energy stores the raw energy of light as mass and momentum; 4) in obedience to the second law of thermodynamics, mass stores the spatial entropy drive of light as its temporal entropy drive. In turn, the intrinsic motion of time produces the gravitational field of matter. Thus entropy produces the dimensional conservation domains of both free energy (space - through the intrinsic motion of light), and of bound energy and information, matter's "causal matrix" - (historic spacetime - through the intrinsic motion of gravitation and time). Spacetime, the joint dimensional conservation domain of free and bound energy, is produced by the intrinsic motions of both c and T, as they are welded together and equilibrated by "G", the gravitational constant and the entropy conversion gauge. This is the iron linkage between the first and second laws of thermodynamics. Noether's theorem is drawn into this web because "velocity c" gauges both the entropy drive and the non-local symmetry state of free energy, and gravitation is likewise (and consequently) a combined symmetry and entropy debt, as we shall discover below. (See: "The Tetrahedron Model").

The Mechanism of Gravitation - Gravity as the Spatial Consequence of Time's Intrinsic Motion

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 gravitational time charge (time is the active principle of gravity's "location" charge), when an electromagnetic wave collapses or becomes "knotted", it switches from the spatial or "wavelength" character of light or 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. The magnitude of "G" (the universal gravitational constant) is

determined by the energy difference between the symmetric spatial entropy drive (S) (the intrinsic motion of light as gauged by "velocity c") and the asymmetric temporal entropy drive (T) (the intrinsic motion of time as gauged by "velocity T"): S - T = -G. This is equivalent to the small energy difference between implicit and explicit time. (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 symmetry of the free energy which created it. This non-local symmetry produced the equitable distribution of light's energy throughout spacetime, a symmetry broken by the concentrated lump of immobile energy represented by bound energy's "rest mass". It is the distributional asymmetry of matter's local energy which is the origin of gravity's "location" charge. The "location" charge records the spacetime position, quantity, and density of the distributional asymmetry of energy represented by any form of bound energy. However, the gravitational "location" charge actually has a double origin (due to the dual gauge function of "velocity c"), both as an entropy debt related to causality and energy conservation, as well as a symmetry debt related to location and charge conservation. Both debts stem from the local nature of matter, both are carried by the time charge of gravitation, and both are paid off simultaneously by the gravitational conversion of bound to free energy, as in our Sun, the stars, and the "quantum radiance" of black holes. (See: " The Double Conservation Role of Gravitation".)

The intrinsic motion of light is caused by the implicit presence of time. In the mathematical formula for light's intrinsic motion, wavelength multiplied by frequency = c. The presence of time is implied by "frequency", the presence of space is implied by "wavelength". In the freely moving wave, the spatial or wavelength component is explicit and dominant; when the wave is stationary, collapsed to a particle or other form of bound energy, the temporal or frequency component of the wave is explicit and dominant, expressing the opposite side of the entropy "coin". Light's intrinsic (self-motivated) motion is actually caused by the symmetric wavelength component "fleeing" the asymmetric temporal component, which is however an embedded characteristic of its own nature, the classic "bur under the saddle". Because light's intrinsic motion suppresses time to an implicit state, metric symmetry conservation in the service of energy conservation is the physical principle or natural law driving the intrinsic motion of light. As we have noticed earlier, however, this same intrinsic motion causes the expansion and cooling of spacetime: "velocity c" also gauges the entropy drive of free energy. Hence both symmetry and entropy must be invoked to fully explain the conservation causes of light's intrinsic motion. The "switching" or "flipping" of the entropy component of the electromagnetic wave from implicit time to explicit time is the whole difference between the intrinsic motion of light and the intrinsic motion of time, the expansion of space vs the gravitational collapse of space, or the positive spatial entropy drive of light vs the negative spatial entropy drive of gravitation. (See: "The Conversion of Space to Time".)

Time is the active principle of gravity's "location" charge, and time is unique among the charges of matter in that it is an entropic charge - a charge with intrinsic dimensional motion. Hence as soon as it is formed, time moves into the expanding historic domain of information (the entropy domain for bound electromagnetic energy), at right angles to all three spatial dimensions (the entropy domain for free electromagnetic energy). However, because space and time are connected, when time moves it drags space after it. It is this spatial motion that we recognize as the gravitational field, but it is actually caused physically by the intrinsic motion of time pulling space along behind it.

As space is dragged after the time charge, it is pulled symmetrically from all possible 3-dimensional spatial positions (because time is connected equivalently to all three spatial dimensions), and at the center of mass or at the time charge itself, space self-annihilates: +x cancels -x, +y cancels -y, and +z cancels -z, leaving behind, of course, a new residue of +t, which cannot cancel because time being one-way, there is no -t. The new time charge replaces the old, which has moved down the one-way,

one dimensional time line into the historic domain of information, and the cycle repeats - the new time charge moves down the time line dragging more space after it, the space self-annihilates at the center of mass (as it tries to squeeze into the zero-dimensional beginning of the one-dimensional time line), producing a new time charge, etc. forever. Hence gravity and time induce each other, creating the continuous one-way flow of time, the continuous one-way flow of gravitation, and a spherically symmetric gravitational field with a local "center of mass" where the field vanishes. The acceleration of the gravitational field is caused by the constant application of a force - the intrinsic motion of time. (The 1/rr attenuation of gravitational force is the simple consequence of the interaction between spherical geometry and energy conservation. The same force law applies to electric fields (Coulomb's law) and to the quenching of stellar luminosities, for the same reasons. Einstein's modification of Newton's law was due to his recognition of the appropriate geometry of spacetime as 4-dimensional rather than 3-dimensional.)

This perspective of the gravitational field is perfectly in accord with Einstein's "Equivalence Principle", which asserts that we cannot tell the difference between the inertial forces of acceleration due (for example) to rocket engines, vs the equivalent gravitational forces experienced as "weight" while resting on the surface of the Earth. In the gravitational case, spacetime moves through us; in the accelerating case, we move through spacetime.

The one-way character of time is a necessary consequence of causality protection and energy conservation for bound energy forms in relative motion, as noted before. The time flow produces information's aging, expanding entropy domain (history), which is the analog of, and derived from, the expanding spatial entropy domain of light. The two are welded into historic spacetime by gravitation; historic spacetime is visible in the stars and galaxies as we look out into space and back into time. (Light's spatial entropy drive is actually visible as the cosmological "redshift".) (See: "A Spacetime Map of the Universe".)

Note that in gravity we have symmetric space "chasing" asymmetric time, exactly the reverse of the situation producing the intrinsic motion of light, where symmetric space "flees" asymmetric time (wavelength multiplied by frequency = c). This is just the difference between explicit and implicit time (reminiscent of David Bohm's "explicate and implicate order"), and the negative and positive spatial entropy drive of gravitation vs light. (See: "The Gravity Diagram 1", and "The Gravity Diagram 2"), and "The New Gravity Diagram".

Quantum Mechanics and Gravitation - Primary vs Secondary Process

Gravitation is both a symmetry debt and an entropy debt of light, unique among the charges and their forces. 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 double conservation role of gravity is due to the double gauge role of the electromagnetic constant "c", both of which gravity conserves. "Velocity c" gauges both the non-local symmetric energy state of light and the spatial entropy drive of light; gravity must conserve both gauge roles of c if it conserves either one. (See: "The Conversion of Space to Time".)

The collapse of an electromagnetic wave confers a quantized time charge on a massive particle. This is the quantum mechanical process of producing the entropy debt or time charge. We can visualize this as the conversion of the "wavelength" or spatial aspect of light or the moving electromagnetic wave, to the "frequency" or temporal aspect of the particle or stationary wave - the "flipping" of the electromagnetic entropy "coin" from "head" to "tails". (see: "Gravity Figure No. 2"). Once this time charge is established, the secondary or symmetry aspect of gravitation comes into play: the cyclic, continuous flow of symmetric space as it is pulled toward the center of the asymmetric time charge by

the intrinsic motion of time, producing the macroscopic gravitational field (see fig. "gravity"). The "secondary" process simply copies or reproduces the time charge established by the one-time "primary" process. We can visualize this secondary process as the actual symmetric flow and annihilation of the spatial dimensions, leaving in their place an uncanceled, ephemeral temporal residue whose intrinsic motion - at right angles to all three spatial dimensions - pulls space along after it, producing the continuous spatial collapse that is a gravitational field (see fig. "gravity1").

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 (the entropy debt) to the macroscopic aspect of gravitational flow (the symmetry debt). Both are linked by their common gauge c and Noether's Theorem requiring the conservation of light's "non-local" symmetric energy state. The gravitational charge, "location", is unique among charges in that its active principle is time. The gravitational charge is an "entropic" charge, a charge with intrinsic dimensional motion. It is the entropic nature of the gravitational charge which connects the quantum mechanical (particle-charge-time-entropy) and macroscopic (mass-location-space-symmetry) aspects of gravity. In turn, the double nature of the gravitational charge gives gravity a double conservation role, on the one hand conserving the entropy drive of free energy by converting space and the intrinsic motion of light to history and the intrinsic motion of time, and on the other hand conserving the non-local symmetric energy state of light by converting bound to free energy (as in the stars, and in Hawking's "quantum radiance of black holes). This duality extends backward in a conservation chain to the dual role of "velocity c", which gauges both the symmetric energy state and the entropy drive of free energy. Gravity must conserve both gauge or regulatory roles of light's intrinsic motion if it conserves either one (see: "The Double Conservation Role of Gravitation").

A gravitational field is the spatial consequence of the intrinsic motion of time. The collapse of space leaves a (metrically equivalent) temporal residue whose intrinsic motion pulls more space after it, in an endlessly repeating cycle. The intrinsic motions of gravitation and time continuously induce each other, much as the oscillations of an electric and magnetic field induce each other. In both cases, the motion of a current, either moving space or moving electrical charges, produces a field at right angles to the current flow (time or a magnetic field). Conversely, a moving time or magnetic field produces a spatial (gravitational) or electric current. Both magnetism and time can be seen as local conservation consequences of distorting the global symmetry of charge and space. (See: "Material Effects of Global vs Local Gauge Symmetry".) (See also: "Currents of Entropy and Symmetry".)

The "graviton" or field vector of the gravitational charge is a quantum unit of matter's temporal entropy drive, the gravitationally transformed entropy drive or intrinsic motion of the photon (S), energetically equivalent to a quantum unit of time (T), symbolically expressed in a "concept equation" as:

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

(See: "Entropy, Gravitation, and Thermodynamics", and "A Description of Gravitation"). For a discussion of the weakness of gravity - which is due to the tangential nature of the contact point between matter's "universal present moment" and matter's causal conservation domain of historic spacetime - see: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".)

Quarks and Leptons

Mass assumes quantized, specific, particulate form as the strong force quarks, baryons, and mesons ("hadrons"), and the weak force leptons. Hadrons are defined as particles containing quarks; hence all

hadrons carry "color" charge, the source of the quark-confining strong force. Leptons contain no quarks and hence 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 massive 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 heavy lepton). Protons and neutrons (the "nucleons") are familiar examples of the "hadron" family: composed of 3 quarks, they are members of the "baryon" subfamily of hadrons; the only other hadrons are the mesons (pions, kaons), 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 (supplying balancing or neutralizing charges in place of antiparticles).

3 Families of 4 Particles

The quarks and the leptons each occur in paired "families" of three 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 discussed):

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

There is no commonly accepted explanation why there should be 3 paired energy levels of particles, or how the quarks and leptons are related. Ordinary matter 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 somehow reflecting the 3-dimensional structure of space (because particles are ultimately derived from the interaction of light's energy with the metric structure of spacetime).

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 (even in stars) consists only of the up, down quarks.

All quarks carry partial electric charges (u, c, t quarks carry +2/3; d, s, b quarks carry -1/3), and their distinguishing charge, color. There are 3 color charges, red, green, blue (not actually colors, just names of convenience) which are exchanged between quarks by a "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 8 effective members of the gluon field. The constant "round-robin" exchange of the gluons from one quark to another is the strong force mechanism which binds the quarks together within baryons and mesons (quark "confinement").

At a higher level of strong force structural order and cohesion, meson exchange binds nucleons

(protons and neutrons) into compound atomic nuclei. This higher-order or nucleon-level expression of the strong force (the "Yukawa" force) is essentially an "oscillation" of the nucleons between their possible neutron or proton identities (sometimes known as "isospin symmetry"). "Isospin" symmetry amounts to an oscillation between quark up and down "flavors", whereas the lower order or quark-level strong force amounts to an oscillation between quark red, green, and blue "colors" (leading in the latter 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 "hive", a veritable metropolis of quantum mechanical action and exchange, all quite beneath our notice, due to the short-range character of both binding levels of the strong force.

Being composed of color-anticolor charges in all possible combinations, the gluon field as a whole sums to zero, a crucial symmetry property ("asymptotic freedom"). Quarks are permanently confined by gluons to meson or baryon combinations; they never occur alone or in any other combination in nature (except possibly a "quark soup" state existing in super-dense stars or at super-high "primordial" energy and temperature). Finally, only quark combinations which electrically sum to zero or unit electrical charge, and neutral or "white" color charge, are allowed. Hence the quark-antiquark pairs composing mesons carry a single color and its corresponding anticolor (such as red-antired), whereas in baryons the colors pair with anticolors in all possible combinations.

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 baron, it is hard to escape the impression that this is what a lepton would have to 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" (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, or what is equivalent, to the long-range forces. 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 would go far toward explaining both the differences and the similarities of these two fundamental classes of particles, including the gluon field, which has been compared to "sticky light".

Fermions and Bosons

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, 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, the gluons of the strong force, and the IVBs (Intermediate Vector Bosons) of the weak force (the IVBs, as their name implies, exhibit characteristics of both groups). Together, the fermions and bosons comprise the particles and forces of matter. Bosons have whole integer spins (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 energy and

charge.

If we add the charges, or symmetry debts of matter (including spin), and the intrinsic motions and inertial forces to the fermions and bosons, we have a complete list of the fundamental (unexcited) energy states of free and bound electromagnetic energy. Historic spacetime is the dimensional conservation domain they create and occupy. The primordial mixture of light and metric spacetime creates fermions; fermions carry charges producing forces whose field vectors are bosons. All forces act to return the material system to the primordial symmetric state of free energy (light) which created it. Thus massive leptons and quarks bear electric charges whose field vectors are photons; elementary particles bear identity charges whose field vectors are the IVBs; all quarks bear color charges whose field vectors are gluons; all forms of bound energy bear gravitational charge whose field vector is the graviton (or spacetime).

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?

We 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 of the "Big Bang" or the "X" IVB), that its color charge vanishes through the principle of "asymptotic freedom" (the gluon field, being composed entirely of color-anticolor charges, 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. 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 decay pathway, which function as alternative charge carriers for the electric, identity, color, and flavor charges of quarks and other leptons.

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 mass quanta permissible in nature? Are neutrinos composite or elementary particles? It is currently believed that neutrinos have a tiny mass and oscillate between their several possible identities, somewhat as the massive leptons, whose identity charges they carry, can change identities among themselves via reversible weak force decays, mediated by the IVBs. (Other examples of "oscillation" have been noted above between quark colors and flavors in the strong force.)

Neutrinos were thought to be massless leptons with intrinsic motion c. They are now thought to have a tiny mass and move very nearly at velocity c because they are both so light and energetic when formed. Neutrinos are the explicit, "bare" form of lepton number ("identity") charge, which is hidden or implicit in the massive leptons (and probably also in the massive baryons and leptoquark).

Each massive lepton (the electron, muon, tau, and 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 this charge. 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 such; all other particles are composites. The conservation domain requires this identity asymmetry to be recognized and accounted for, but it 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 timely annihilation reactions, the identity charges make their contribution to conserving light's symmetry. Identity charge also plays a role in the quantization of elementary particle mass (as do the "flavor" charges of the quarks), such that these specific particle masses can be reliably, accurately, and indefinitely reproduced.

Neutrinos are quanta of information, keeping the symmetry records of spacetime concerning the identity and number of all elementary particles (or antiparticles) within its domain. Combined with the metrical warpage of gravitation, we see that spacetime contains structural information concerning the location, mass, and identity of every elementary particle within its conservation domain. This startling fact informs us that spacetime is as scrupulous concerning symmetry conservation as it is concerning raw energy conservation. Not only is every hair on your head numbered, but every elementary particle in that hair is numbered and its mass and location known. (We also discover that the historic record of spacetime is complete in the conservation domain of matter's causal information matrix. We, and all our activities, are immortal in historic spacetime.) "Every jot and tittle of the law will be fulfilled." (See: "A Spacetime Map of the Universe".)

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