Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 2

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home page

There is nothing so valuable as a fresh perspective

Table of Contents:

Go to: "Symmetry Principles of the Unified Field Theory: Part 1"
Go to Summary Section (Part III)

Abstract: (from Part I:)

The conceptual basis of the Unified Field Theory as presented in these pages is summarized below:

"Noether's Theorem" states that in a multicomponent field such as the electromagnetic field (or the metric field of spacetime), symmetries are associated with conservation laws and *vice versa*. In matter, light's (broken) symmetries are conserved by charge and spin; in spacetime, light's symmetries are protected by inertial forces, and conserved (when broken) by gravitational forces. All forms of energy originate as light; matter carries charges which are the symmetry/entropy debts of the light which created it (both concepts are required to fully integrate gravity - which has a double conservation role - with the other forces). Charges produce forces which act to return the material system to its original symmetric state (light), repaying matter's symmetry/entropy debts. Repayment is exampled by any spontaneous interaction producing net free energy, including: chemical reactions and matter-antimatter annihilation reactions; radioactivity, 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 charges and forces of physics is the first step toward a conceptual unification.

The charges of matter are the symmetry debts of light. In weak gravitational fields (as on planet Earth), gravity only pays the entropy "interest" on the symmetry debt of matter, converting space to time, providing an alternative entropic dimension (history) in which charge conservation (and causality) can have an extended significance. In stronger fields (as on our Sun), gravity also pays the "principal" of matter's symmetry debt, converting mass to light; this latter reaction goes to completion via Hawking's "quantum radiance" of black holes.

The symmetry-conserving requirement of *charge invariance* (and of "Lorentz invariance" in Special Relativity) is the key to understanding the local action of the forces, including the quantization of charge and other conserved parameters.

While atomic nuclei promote symmetry conservation through an exothermic nucleosynthetic pathway in stars, their associated electron shells create life through a negentropic chemical pathway on planets. Using energy and heavy elements ultimately provided by gravity, the information pathway of biology is the means whereby the universe becomes aware of and experiences itself, including evolving new modes of creativity. Carbon with its multiple 4x3 fractal resonances (5) is the crucial link between the abiotic and biotic metrics of the Cosmos.

See: the "Tetrahedron Model" (simple version) (diagram)
The Tetrahedron Model (complete version) (diagram)

Row 3 - Charges: The Symmetry Debts of Light

Row 3: "Mortgage", "pay later", "pay through time", time deferred payment. Symmetry and charge conservation in obedience to Noether's Theorem are the primary topics of Row 3. Each of the 4 forces is examined in terms of its motivating charge and the broken symmetry of light from which that charge originates, and which that charge represents, carries, and conserves. Quantized charges are conserved through time for payment at some future date. Quantization is part of the mechanism ensuring charge invariance, a mechanism which also includes "local gauge symmetry currents". Charge conservation is a temporal form of symmetry conservation. Gravitation pays the interest on this "mortgage" or symmetry debt by creating matter's time dimension, taking the necessary energy from the spatial expansion of the Cosmos, which decelerates accordingly. Time is the relevant dimensional context in which concepts such as "time deferred payment" or "repayment of a conserved debt or charge" can have meaning. Hence symmetry conservation through time via the mechanism of conserved charges provides another rationale for gravitation - in addition to balancing the primordial positive energy of Creation, and providing a temporal accounting for the relative motion of massive particles.

I include in this section a discussion of the global vs local gauge symmetry model for each force. It is primarily in the invariance of charge as translated between global vs local metrics and energy states by the field vectors of the forces that a synthesis between the "Tetrahedron Model" and the "Standard Model" of "establishment" physics can be made, at least in terms of symmetry conservation and Noether's Theorem.

Electric Charge
(row 3, cell 1)

The charges of matter are the symmetry debts of light. Charge/spin conservation is a temporal form of symmetry conservation. Forces generated by matter's charges are the demand for payment of the symmetry debts those charges represent. Noether's Theorem is the formal theory addressing the conservation of the symmetry of free electromagnetic energy (radiation, light). Charges are quantized to help protect their values from inflation or deflation over time by entropy or relative motion in spacetime; otherwise, charge conservation would have little meaning. This is also one of the reasons why matter must be separated and protected from the expansive or enervating effects of its primordial entropy drive, time. Whereas light participates in the entropic expansion of its spatial conservation domain, matter does not participate in the entropic expansion of its causal information matrix, the historic domain of spacetime; matter maintains a tangential position with respect to history, existing only in the "universal present moment". (See: "The Time Train".) Magnetic forces are also instrumental in protecting the invariance of electric charge in relative motion. (See: "Global vs Local Gauge Symmetries and the Tetrahedron Model".)

We do not ordinarily realize that the symmetry of energy is conserved as well as its total amount, but it has been known for a long time that this must be true. In a famous theorem, Emmy Noether proved mathematically that in a continuous multicomponent field, such as the electromagnetic field (or the metric field of spacetime), wherever there is a symmetry one also finds an associated conservation law, and vice versa. This theorem has become the mathematical basis ("group theory") for modern efforts to unify the forces. In the model presented here, I trace the unity of the forces back to their common origin as the conserved debts of light's broken symmetry. (See: "Emmy Noether: A Tribute to her Life and Work").

Charges arise naturally from the process of symmetry-breaking. When virtual particle-antiparticle pairs are created from light, each member of the pair carries various charges which function to ensure instant and successful annihilation, reconstituting the light from which the pair was created. Since light itself carries no charges, it can only create particle pairs whose charges balance, cancel, or neutralize each other, summing to zero. The positive/negative electric charge is prototypical of this effect.

Initially, all massive elementary particles are created in particle-antiparticle pairs, with equal but opposite electric charges (among others) summing to zero. Opposite electric charges attract each other powerfully, and at long range, allowing the particles to find each other anywhere in space and recombine, motivating an annihilation reaction which returns their bound energy to light, conserving the symmetry of the free energy which created them. Since photons, or light quanta, are the field vectors (force carriers) of electric charge, we see light actively protecting its own symmetry in matter-antimatter annihilation reactions, through the forces generated by electric charge. Finally, because the electrical annihilations of virtual particles are caused by photons traveling at velocity c, virtual particles are created and destroyed within the Heisenberg time limit imposed upon virtual reality. Virtual particles do not live long enough to exist in "real" time, and hence they also, like the light which created them, cannot produce a gravitational field. (Virtual pairs *which may be interpreted* as associated with a particle's "*observed mass*" are, in such a case, obviously contributing members in a local system of bound energy, and therefore are exceptions to this rule, which is strictly true only for massless non-local photons in free flight.)

When one member of a particle-antiparticle pair is isolated, as by the asymmetric decay of matter-antimatter leptoquark pairs during the Big Bang, the conserved charges of that isolated particle, which were intended to motivate and facilitate an annihilation reaction with its antimatter partner, are simply "hung" in time. The isolated particle is one-half of a symmetric particle-antiparticle pair, one-half of light's symmetric particle form, and its uncanceled but conserved charges are one-half of light's symmetry-keeping forces and mechanism. These charges can therefore be fairly characterized as the active "debts" or asymmetric remnants of light's broken symmetry - a temporally conserved form of light's symmetry, just as mass is a temporally conserved form of light's raw energy.

The charges of matter are the symmetry debts of light. Light has global, timeless, non-local symmetry; charges are a local, temporal transformation of light's global symmetry. Local symmetry is global symmetry in a temporally conserved form. Charge-neutral, cold, atomic matter represents a "ground state" of local, temporally conserved symmetry. Gravity is the only charge of matter that cannot be neutralized - because of gravity's double conservation role as both an entropy debt and a symmetry debt of light. The entropic component (time, history) of the gravitational charge must continuously increase, until it is satisfied by the return of bound to free energy (as in the stars).

While electric charge is always associated with mass, it is independent of the quantity of mass; the three leptonic particles electron, muon, and tau, for example, have vastly different masses but carry the same electric charge. Electric charge is not associated with bosons which move with intrinsic motion c, such as the gluon, photon, or graviton. There is definitely a major, general asymmetry associated with the loss of light's intrinsic motion which electric charge is powerfully guarding against, and we would like to distinguish it from the asymmetry associated with the gravitational charge. The gravitational constant (G), the electromagnetic constant (c), and the magnitude of electric charge (e), are all invariant; all their values are also independent of the quantity of energy with which they are associated.

The asymmetry I single out as the cause of electric charge is dimensional: light is 2-dimensional, mass is 4-dimensional. Light lacks the x, t dimensions of bound energy, as Einstein discovered. The jump from 2 to 4 dimensions in the conversion of light to particles (or bound to free electromagnetic energy) is a general loss of symmetry, since the 4th dimension inevitably includes time, which is an asymmetric, one-way dimension. It is this particular asymmetry, time, which electric charge protects against. Electric charge, through matter-antimatter annihilations, protects light's "non-local" dimensional symmetry by preventing light from devolving into local matter, gravitation, and the asymmetric time dimension which is matter's entropy drive and which provides matter's causal linkage. Electric charge is not related to the quantity of mass because the dimensional asymmetry of time applies equally to all 4-dimensional massive forms, irrespective of magnitude. Like most symmetry debts, electric charge is a charge of "quality" not "quantity". Raw energy debts (mass, momentum) are "quantity" debts. Gravity is unusual in that it partakes of both, as gravity is both an entropy debt of light (quantity - "pay now") and a symmetry debt of light (quality - "pay later") - see below.

The Magnetic Field

(See: "Global and Local Gauge Symmetry and the 'Tetrahedron Model'")

From the global vs local gauge symmetry viewpoint, the magnetic field of a moving electric charge constitutes the local symmetry "current" (the compensatory component of the field vector), that translates the relative motion of an electric charge into an electrical form (magnetism) that does not affect - and hence protects - the invariant magnitude of its source charge. The electric charge is the global symmetry state (or debt), invariant and universal, independent of the mass of any carrier (such as the electron or proton), and likewise invariant with respect to any relative motion - thanks to the local gauge symmetry current of the magnetic field.

Because charges represent symmetry debts which must be paid in full upon demand (as for example when they annihilate with an antiparticle or neutralize an anticharge), symmetry conservation and charge conservation would have little meaning if such debts were inflated or diminished by entropy, age, gravitation, or relative motion. Therefore, all four forces have some compensatory component in their field vectors which act to preserve the invariance of the original, global values of charge as they are translated and transferred to new or material carriers, or otherwise interact with the relative and variable realm of matter. The role of the field vectors is to enforce and maintain symmetry-keeping by protecting charge invariance until such time as they can actually completely "pay off" the symmetry debt by annihilation with antimatter.

In the case of the electromagnetic force, the local compensatory component of the field vector (the photon or electromagnetic quantum) is the magnetic field; in the case of gravitation, the analogous component is time (in which conception the field vector of gravitation is taken to be spacetime); in the case of the strong force, it is the color-anticolor composition of the gluon field and the curious short-range character of the strong force (which gets stronger with distance), producing both "asymptotic freedom" and the permanent confinement of quark partial charges, protecting whole quantum charge units; in the case of the weak force, it is the great mass of the IVBs (as gauged or scaled by the Higgs boson), and the particle-antiparticle composition of the alternative charge carriers in their virtual modes, creating invariant "singlet" elementary particle masses and charges (single electrons created today must be the same in all respects as single electrons created eons ago during the "Big Bang"). To this end, the great mass of the weak force Intermediate Vector Bosons recreates the original environmental conditions of the force-unity state in which the elementary particles in question were originally formed (for example, the "W" IVB family recreates the electroweak force-unity state).

A somewhat analogous example is provided by the Doppler effect of moving light sources, in which the frequency or color of light changes in response to relative motion, leaving the velocity of light invariant.

Gravitational Charge

(row 3, cell 2)

(See: "The Double Conservation Role of Gravitation")

In row 2 we emphasized the gravitational conservation role with respect to entropy, the creation of matter's time dimension, and the conservation of energy (raw energy conservation). Here in row 3 the gravitational role emphasized is with respect to the "location" charge, and the asymmetric distribution of matter (or bound energy) in spacetime (symmetry conservation). The two major conservation roles of gravitation (entropy and symmetry) are derived from the double role of velocity c as the entropy and symmetry gauge of free energy.

Gravitation is a dimensional or "spacetime" charge, at once the most common and familiar, but perhaps the most mysterious and intractable to explain. The symmetry debt associated with gravitation is "location", representing the (broken) spatio-temporal distributional symmetry of light's "non-local" character. When light is converted to mass, light loses its intrinsic motion and hence its non-local symmetric energy state. Whereas light (in its own reference frame) is everywhere simultaneously within its conservation domain (having no "x" or "t" dimension, light's Interval = 0), mass has "intrinsic rest" and acquires a time dimension (via its gravitational "location" charge) and a positive Interval. The distributional symmetry of light's energy within spacetime is therefore broken; mass is a concentrated lump of undistributed energy with a specific location (x, y, z, t) in spacetime. The location of matter is actually identified energetically and inertially in terms of both the quantity and density of bound energy by the warped metric produced by the gravitational field of mass. Whereas light is 2-dimensional, mass is 4-dimensional; the acquisition of the extra dimensions (x, t) identifies the spacetime coordinates and specific location of immobile mass-energy.

But the gravitational charge is unusual in that it is more than just a "location" symmetry debt; unlike electric charge, color, or number, gravity is also an entropy debt of light. The gravitational force creates time and spacetime (bound energy shares spacetime with free energy as a compound electromagnetic conservation domain), converting space to time, via the annihilation of space and the extraction of a metrically equivalent temporal residue. Gravity and time induce each other: they are both the primordial expressions of entropy in matter.

-Gm = the negentropic energy of mass, the energy associated with the time dimension of bound energy (T)m. The complexity of gravitation is due to the fact that its conservation function addresses both the first and second laws of thermodynamics (through time, causality, and entropy), as well as symmetry conservation (through the "location" charge and the positive Interval), simultaneously. The active principle of the gravitational "location" charge is time, which is both a symmetry (4-D location) and an entropy (intrinsic dimensional motion) debt. It is gravitation's entropic character that causes it to so aggressively and relentlessly pursue its symmetry conservation agenda (the conversion of bound to free energy, as in stars) - unlike electric charge, for example, which is only a symmetry debt and is readily neutralized. (See: "The Double Conservation Role of Gravitation".)

Think of the round, full Moon and the Sun; although they are of the same apparent size in the sky, they illustrate for us the vast difference (and apparently opposite reactions) characteristic of the two great conservation roles of gravity. The Moon illustrates gravity's proximate entropy (and hence energy) conservation role (the conversion of space to time); the Sun demonstrates gravity's ultimate symmetry conservation role (the conversion of bound to free energy). The balance of these two opposing forces stabilizes the sun's energy output. Furthermore, the Moon can eclipse the Sun, as in the triumph of temporal entropy in a black hole; this victory is ephemeral, however, as Hawking's "quantum radiance" reasserts the supremacy of light's symmetric spatial entropy and gravity's symmetry conservation role. Hence gravity's double conservation role is paraded before our eyes daily, even including an allegory of their sometimes antagonistic interactions (a conflict also played out in the ocean tides). It is no wonder that humans have always found in the heavens a metaphor of the divine.

Gravity is a collapsing spatial wave centered on a massive particle whose dynamic is supplied by the intrinsic motion of time, the entropy drive associated with the bound energy of the particle. The collapse of space produces a metrically equivalent temporal residue, whose entropic march into history collapses more space in an endless self-regenerating cycle. (See: "The Conversion of Space to Time".) The temporal entropy drive thus supplied to matter is the conserved form of the primordial spatial entropy drive which resided in the annihilated space - the transformed intrinsic motion of light (implicit time transformed to explicit time). Implicit time drives the intrinsic motion of light and the expansion and cooling of space; explicit time supplies the intrinsic motion of matter's temporal dimension and drives the expansion and aging of history. The temporal entropy drive of matter is not quenched until gravity succeeds in returning bound energy to its original free state, as seen in stars (partially) and via Hawking's "quantum radiance" of black holes (completely), fulfilling the mandate of Noether's Theorem regarding the conservation of light's symmetric non-local energy state. This is the gravitational pathway of symmetry conservation, employing the engine of (temporal) entropy. The electrical pathway (of symmetry conservation) is via chemistry and matter-antimatter annihilations, and the strong and weak force pathways are through particle fusion, fission, and proton decay - all with the same end, the conservation (restoration) of light's symmetric energy state. (See: "Entropy, Thermodynamics, and Gravitation".)

Global vs Local Gauge Symmetry in Gravitation: Symmetry Conservation

(See: "Global vs Local Gauge Symmetry in Gravitation"

In the gravitational case (which is essentially that of the spacetime metric), the global symmetry is gauged by the electromagnetic constant "c", and characterized by space and the "non-local" distribution of light's energy. Light's "Interval" = 0, and light has no time dimension or "x" dimension (in the direction of propagation). Having no time or distance parameters, light has forever to go nowhere: the result is that light is everywhere within its spatial conservation domain simultaneously. All spatial coordinate positions in space are equivalent to light; light favors no particular "location". This is light's global symmetry condition of "non-locality", the consequence of light's intrinsic motion or spatial entropy drive, "velocity c". ("Light" = any form of electromagnetic radiation or free electromagnetic energy; "matter" or "mass" = bound electromagnetic energy.)

However, light's symmetric spatial distribution does not hold for matter, the central player (with time and gravitation) in the local gauge symmetry. Matter is a concentrated, immobile lump of bound energy with no spatial distribution, and with no (net) intrinsic spatial motion. The "Interval" of matter is always greater than zero, due to the explicit presence of the time dimension and three full spatial dimensions. While matter is the local energy form (in contrast to global light), time is the local dimension (in contrast to global space). The "location" charge of gravity responds to the broken symmetry of light's non-local energy state as represented by local matter (or any form of bound energy). The gravitational "location" charge identifies the position, magnitude, and density of any violation of free energy's distributional symmetry, such as represented by immobile mass-matter. The active principle of the gravitational "location" charge is time. Time specifies the

4-dimensional position of matter in an ever-expanding, entropically driven spatial universe. A gravitational charge specifies an energetically and inertially preferred location in spacetime (the center of mass, the present moment: "here and now"). (Just to be completely clear - bound and free forms of electromagnetic energy are interchangeable, as matter-antimatter annihilations demonstrate, and one is always created from the other (as virtual particles demonstrate). Hence massive particles carry symmetry, energy, and entropy debts of light because bound energy forms are ultimately created from free energy forms.)

The intrinsic motion of the entropic time dimension (time is produced by the quantum mechanical and gravitational collapse of space) pulls space along into the point-like beginning of the time line, leading into the historic domain. Space self-annihilates at the point center of mass, leaving behind a metrically equivalent (but one-way) temporal reside, which also marches off into history, repeating the endless, self-feeding neg-entropic cycle. Meanwhile, all material objects are carried toward the gravitational center of mass by the flow of space, resulting eventually in huge astronomical accumulations of matter (planets, stars, galaxies), in which bound energy is returned to its symmetric (and spatially pos-entropic) form of light by such processes as nuclear fusion, the nucleosynthetic pathway of stars, supernovas, quasars, and the complete gravitation conversion of bound to free energy by Hawking's "quantum radiance" of black holes.

This is the symmetry conservation role of gravitation as distinct from its energy conservation role discussed in row 2 (above). Here in row 3, we focus on the non-local distributional symmetry of light's energy and light's zero "Interval" as consequences of light's intrinsic motion (following from the suppression of asymmetric time by the metric symmetry gauge "velocity c"). In row 2, we focused on the entropic role of light's intrinsic motion, expanding and cooling space, and the entropic role of the gravitational production of time, conserving light's spatial entropy drive in the form of matter's temporal entropy drive. Time also conserves the energy accounts of matter in relative motion, protects the causal linkages of matter (and the invariance of matter's "Interval"), and creates historic spacetime, the conservation domain of matter's causal information "matrix" or network.

The principle of charge invariance in the gravitational case is found in the invariance of the universal gravitational constant "G", and in the invariance of the "Interval" and "causality". Massless light is non-local, atemporal, and acausal; massive matter is local, temporal, and causal. When light or free energy is transformed to matter or bound energy, the invariant, zero "Interval" or non-local (and acausal) symmetric energy state characteristic of light is transformed by gravity into the equally invariant but positive "Interval" of matter, with matter's temporal component and causal linkages. This transformation accords with the symmetry-conserving mandate of Noether's Theorem, and the energetic necessity to conserve local matter's causal linkages and temporal relations, as well as the invariance of velocity c (through the flexible time dimension and "Lorentz Invariance").

The covariance and interchangeability of time with space are necessary to the invariance of matter's Interval - as per Einstein's Special Relativity. Again, relative motion is involved (in matter), rather than absolute motion (in light). Relative rather than absolute motion requires flexible dimensions to maintain the invariance of matter's "Interval": with respect to the protection of charge invariance, time is the metric analog of the magnetic field of electric charge. Moving clocks run slow; the effect of relative motion upon the local clock rate varies with velocity ("Lorentz Invariance"), just as the strength of a magnetic field varies with the relative velocity of an electric charge. One can view the magnetic field associated with the relative motion of an electric charge as entirely analogous to the dimensional "warpage" of "Lorentz Invariance" - the magnetic case conserving the invariance of electric charge, the dimensional case conserving the invariance of causality, the Interval, and "velocity c".

The tenacious gravitational charge associated with the positive Interval of matter (the "location" charge whose active principle is time) will not be satisfied until matter is finally converted to light. Once this symmetry restoration (conservation) is accomplished (as in stars), time and the gravitational field vanish, as light has neither. We may regard the radiance of our Sun and the stars as a triumphant announcement of the achievement of gravity's symmetry conservation goal.

Energy conservation within a temporal, relative, and local metric (as gauged by the universal gravitational constant "G"), rather than within a spatial, absolute, and global metric (as gauged by the universal electromagnetic constant c), is the local gauge symmetry "ground" state of row 2 (raw energy and mass conservation). Planet Earth, and the Earth-Moon orbital system, are typical examples of this quiescent, gravitational "ground state" of local symmetry and energy conservation - comparable to the electrically quiescent ground state of cold, charge neutral, atomic matter. On the other hand, "location" charge and symmetry conservation in terms of the restoration of light's non-local symmetry by the gravitational conversion of mass to light, is a topic for row 3 (symmetry and charge conservation). Our Sun is a typical example of this active gravitational stage, a completed "circuit" of symmetry conservation - comparable to the weak force radioactive decay of atoms, and the strong force fusion of compound nuclei. (See: "Currents of Symmetry and Entropy".) Of course, both nuclear forces make use of gravitational energy to effect their contributions to the solar/stellar nucleosynthetic pathway of energy conversion and element building.

Gravitation produces both an energy-conserving and symmetry-conserving local temporal metric for matter (gauged by "G"), derived from, imposed upon, and conserving the global spatial metric of light (gauged by "c"). In both cases, time is the compensating and variable local gauge symmetry component of the gravitational field vector (spacetime or the graviton). Time conserves energy and entropy, and the invariance of causality, the "Interval", and velocity "c" on the one hand, while simultaneously conserving symmetry by identifying the coordinate position, magnitude, and density of bound energy on the other. The latter information (provided in the inertial or metric terms of an energetically preferred spacetime "location charge"), results in the eventual conversion of mass to light, as in the stars. Gravity accomplishes the transformation of a global spatial metric to a local temporal metric (and back again), by the gravitational annihilation of space and the extraction of a metrically equivalent temporal residue, followed by the gravitational annihilation of matter and the extraction of energetically equivalent light - as in stars and via Hawking's "quantum radiance" of black holes. (See: "Global and Local Symmetry in Gravitation"; see also: "The Conversion of Space to Time" and "The Double Conservation Role of Gravitation".)

For a more complete discussion of the gravitational charge and its mechanism, see: "Entropy, Gravitation, and Thermodynamics" and "A Description of Gravitation".

Strong Force Binding in Compound Atomic Nuclei

(row 3, cell 3)

(See: "The Strong Force: Two Expressions")

There are two types or structural levels of the strong force, one involving binding the individual quarks inside baryons via "color" charges and the exchange of gluons (discovered by Murray Gell-Mann and George Zweig (1964)), and the other involving binding nucleons (protons and neutrons) in compound atomic nuclei via "flavor" charge and the exchange of mesons (discovered by Hideki Yukawa (1935)). These are very different forces, even though both involve nuclear material and both are called "strong", and they have very different consequences: quarks are permanently confined, and can never escape the binding force of the gluon field; nucleons are tightly held, but given sufficient energy, can and do escape the grasp of the meson field (as in radioactive decay). The gluon-level strong force is the consequence of charge and symmetry conservation; the meson-level strong force is the consequence of a "least bound energy" principle, which is also related to symmetry conservation, but through a raw energy pathway rather than through charge conservation. (See: "The Strong Force: Two Expressions".)

What is the conservation basis of the meson binding force of the compound atomic nucleus? It is evidently the simple fact that when nucleons are herded together in sufficiently close aggregations, they are able to exist in a lower bound energy state than when they exist singly. Just like poor college students, they find that sharing an apartment or room is cheaper than living alone. And any condition or state that reduces bound energy and releases free energy is favored by the conservation laws, especially by symmetry conservation.

So what is it about the communal state of heavy nuclei that is so energetically favorable for the individual nucleon? It apparently has to do with the clouds of virtual particles which surround any real particle, and which constitute a part of the bound energy state or mass endowment of "real" particles.

The quark composition of a neutron is udd, that of a proton is uud+. The only difference between them is a single u or d quark, and these are very nearly the same in mass. In virtual reality, it is a relatively simple matter for a u<u>d</u>+ meson to change a neutron into a proton, and for a <u>u</u>d- meson to change a proton into a neutron (antiparticles underlined). Note how the u<u>d</u>+ and <u>u</u>d- mesons together make a neat particle-antiparticle meson pair. Protons and neutrons, if they are sufficiently close together, will find themselves constantly being transformed into one another simply by the exchange of these mesons in their surrounding virtual particle fields. In fact, they can get rid of some of these virtual mesons if they are close enough to share them, and share also the energetic cost of their production and maintenance. Hence sharing these (very similar) virtual particle fields is a means of reducing their bound energy content, if these nucleons can come together closely enough and in suitable combinations. The (individually and collectively) reduced mass energy of the nucleons then becomes a binding principle or "glue" - any energy liberated during fusion must be replaced if the proton or neutron is to be made whole again and become free. (Note the similarity to covalent chemical bonds in which electrons are shared between the orbital shells of adjacent atoms.)

The most energy-efficient nucleon combinations are called alpha particles, or helium nuclei, consisting of 2 protons and 2 neutrons. I point out elsewhere that this is a prototypical 4x3 General Systems resonance or fractal combination - 4 nucleons each consisting of 3 quarks. (See: "Nature's Fractal Pathway".) The alpha particle is an especially stable nuclear configuration, and becomes the "brick" or standard building block of the stellar nucleosynthetic pathway. (See: "The Fractal Organization of Nature".)

As the compound atomic nucleus grows in size, there is a diminishing energetic return (in terms of the release of binding energy) with the addition of each new nucleon. This is because the shared field of virtual particles eventually becomes saturated - all the advantages and possibilities for sharing the burden of virtual particles have already been explored and exhausted. There's just no more room at the commune. Furthermore, the collective long-range electrical repulsive forces of the protons finally increase beyond the strength of the short-range binding energy of any individual new proton trying to join the party.

After the nucleus has grown to iron 26 (56 nucleons), fusion nucleosynthesis becomes endothermic - as much (or more) energy must be expended to break through the "front wall" of nuclear electrical resistance as is gained by the release of binding energy. However, given an external source of energy to surmount the initial barrier (such as gravitational acceleration), enough nuclear binding potential energy remains available to grow compound nuclei (in nature) up to uranium 92 (238 nucleons). Humans have created more than two dozen "trans-uranic" heavy nuclei in accelerators, of which plutonium is the best known example. Most are extremely short-lived.

The Strong Force Color Charge

As noted above, there are three "color" charges which are exchanged between quarks by the "gluon" field; gluons are composed of a color-anticolor charge pair. The constant "round-robin" exchange of the massless gluons (at velocity c) from one quark to another is the strong force mechanism which binds the quarks together. There is a strong resemblance between color and electric charge (gluons have been compared to "sticky light"), suggesting that the strong force gluon field is possibly derived directly from the electromagnetic force (see below).

Quarks are sub-elementary particles, as we know from their fractional electric charges which are either 1/3 or 2/3 of the unit charge carried by the truly elementary leptons such as the electron. Allowed quark combinations always sum to zero or unit leptonic values of electric charge: the proton is +1, the neutron 0, mesons are 0, +1 or -1. The symmetry which the strong force is protecting is this whole quantum unit of electric charge, the elementary leptonic charge, and whole unit charges generally. If quarks were not confined as they are, there would be no way to annihilate or even neutralize their partial electric charges, or other partial charges they may carry (such as color and identity) - other than by anti-quarks, which would result in annihilations. Symmetry could not be conserved (as charge) in permanent matter if individual quarks and anti-quarks roamed free. The strong force protects symmetry conservation in permanent forms of matter by confining these sub-elementary particles into whole quantum unit packages of charge which can be neutralized, cancelled, and/or annihilated by elementary unit anticharges (such as the electron). The strong force protects the quantum mechanical requirement of whole unit charge in the service of symmetry conservation in permanent forms of atomic matter.

If one were to fracture an elementary leptonic particle into three parts, but require that when it became "real in time" it must retain its "virtual" leptonic character in terms of whole quantum units of charge, one would need a confining force with exactly the characteristics of the strong force as produced by the gluon field of the color charge. And just as the quarks appear to be the remnant of a fractured lepton, so the gluon field appears to be the remains of a fractured photon - "sticky light" - the divided field vector of a divided leptonic electric charge. Earlier we noted that the ability to assume electrically neutral internal configurations (as in the neutron or neutral leptoquark) was the fundamental reason why the baryon must be a composite particle, if it is to break the symmetry of the primordial particle-antiparticle pairs (via the asymmetric weak force decay of electrically neutral leptoquark-antileptoquark particle pairs). (See also: "Proton Decay and the Heat Death of the Cosmos"; and: "The Origin of Matter and Information".)

The strong force represents a compromise between the necessity of cosmological symmetry-breaking and the requirement of quantum mechanical whole-unit charge symmetry-keeping: the irresistible agenda meets the immovable principle. The force of the collision accomplishes the impossible, but via an accommodation - the "virtual" fracturing of an elementary particle with the permanent confinement of its quarks and partial charges.

The strong and weak forces (the "short range" particle or nuclear forces), form a symmetric-asymmetric force pair which is essential to the creation of matter. In this regard, they are curiously similar to the two "spacetime" forces, electromagnetism and gravitation (the "long range" forces). (See: "Diagram of the Spacetime and Particle Forces".)

The principle of "asymptotic freedom" illustrates the symmetry-keeping role of the strong force. As the quarks move apart, their partial charges increasingly threaten the symmetry-keeping function of whole quantum unit charges, and the strong force responds by strengthening its grip. Conversely, as the quarks move closer together, the threat to whole charge unit symmetry-keeping posed by the quark's partial charges diminishes, and the strong force relaxes. If the quarks were to completely rejoin in their original leptonic or leptoquark configuration, the strong force would completely disappear (self-annihilate).

Strong Force Global and Local Gauge Symmetry

Proton decay has never been seen, and we many fairly presume that it requires the mediation of the "X" IVB, a very massive particle, the "big brother" of the "W" IVB. The function of the "X" IVB is the same as that of the "W" IVB - to recreate the metric and energetic conditions in which the particles and transformations it now mediates were originally produced (baryon genesis in the "Big Bang" during the "GUT" era of strong and electroweak unification). Only in this way can the multiple conservation issues (of charge invariance and symmetry conservation) surrounding the partial charges of the quarks be resolved, which are analogous to, but even worse than, the conservation issues confronting the alternative charge carriers for which the "W" is required (because quark partial charges require the additional "gluon" field). (See: "The Particle Table"; see also: "The Higgs Boson and the Weak Force IVBs".)

The gluon field, the field vector of the strong force, is composed of color-anticolor charges in every combination. The gluon's anticolor component is necessary to annihilate the quark's old color charge, allowing its replacement by the new color component. The analog of the magnetic field in the electromagnetic force, and time in the gravitational force, is the confining action of the gluon field, as it is confinement which restores the partial quark charges to whole quantum unit charges, protecting charge invariance and symmetry conservation. The field vectors of all the forces are their own antiparticles, either individually, or in sum. It is specifically this characteristic which allows the field vectors to communicate (in either direction) between the global realm of light (which is symmetric with respect to particles vs antiparticles), and the local realm of matter-only particles.

In the strong force, whole quantum unit (elementary) charges constitute the universally invariant global gauge symmetry (ultimately derived from the elementary leptons via the decay of the leptoquark), while the partial charges of the quarks represent the local gauge symmetry, and the gluon field represents the local gauge symmetry "current" exchanging one color for another, and increasing or decreasing in strength as the relative motions of the individual massive quarks increases or decreases the radius of the baryon. The gluon field functions to combine and maintain the various partial quark charges (color, spin, electric, flavor) into whole quantum unit charges, which can be neutralized and/or annihilated by whole elementary charges, including those of the alternative charge carriers (leptons, neutrinos, and mesons). Neutral heavy elements, for example, represent the ground state of a local gauge symmetry achieved despite the various partial charges of the quarks or their individual motions relative to one another; or the relative motion of the electron vs the proton; or the fact that the electron and proton are not each other's antiparticles; or the fact that compound atomic nuclei are composed of two different kinds of baryons. (In the latter case, as noted earlier, the local gauge symmetry current is composed of mesons exchanged between protons and neutrons, maintaining so-called "isospin symmetry", the combined state of the proton and neutron recognized as the "nucleon".) The field vectors of the forces are local gauge symmetry "currents" which function to translate global gauge symmetries of light, absolute motion, and "virtual" particles into local gauge symmetries of mass, relative motion, and "real" particles; these local states nevertheless conserve (and eventually restore) the global symmetries via the principles of energy, charge, and symmetry conservation.

The Weak Force: Lepton "Number" or "Identity" Charge

(row 3, cell 4)

(See also: "The Weak Force: Identity or Number Charge")

The leptonic charge is known as "number" charge. I prefer to call it "identity" charge, a name which better reflects its reason for existence. Photons (individual light quanta) are indistinguishable and anonymous. They are all alike, and hence form a symmetry of identity which I call "anonymity". Elementary particles, on the other hand, are not all alike (except with respect to their own kind); they are distinguishable between "species" and distinguishable from the photon.

We know of three distinct massive elementary particles, comprising the leptonic spectrum or series: electron, muon, and tau, differing in their masses which increase (dramatically) from electron through muon to tau. Each has a specific neutrino associated with it, which functions as an alternative carrier of leptonic "number" ("identity") charge. (Neutrinos are the "bare" or "explicit" form of "identity" charge, which is also carried in "hidden" or implicit form by the massive leptons).

The leptonic series has the appearance of a quantum mass series - that is, these elementary particles are always created with a specific, discreet mass and no other; there are no elementary massive particles in the gaps between their mass "slots", much like the discreet gaps between the rungs of a ladder, or the energy levels of atomic electron shells. The neutrino that is associated with each massive lepton is evidently the hallmark of the truly elementary particle (the sub-elementary quarks have no associated neutrinos).

It seems likely, however, that there is an undiscovered neutrino associated with the ancestral particle which gave rise to the quarks and baryons, which I assume to be the heaviest member of the leptonic series, the so-called "leptoquark". If we ever see proton decay, we would expect to see a leptoquark neutrino produced in the process. (The leptoquark neutrino is possibly the source of the "dark matter" or "missing mass" of the Universe.)

The lepton "number" or "identity" charge evidently facilitates particle-antiparticle annihilation reactions by allowing the partners to identify suitable "mates" in a timely fashion, and by the handedness of neutrino spin neatly distinguishes matter particles from their antimatter counterparts. Neutrinos also comprise a type of accounting system, recording the number and identity of elementary particles (or antiparticles) contained within the conservation domain of spacetime.

Identity or number charge plays a special role in the creation of the material universe. We can characterize the light universe, before the creation of matter, with just 2 numbers representing its symmetric charge state: Interval = 0, and Number = 0. After the creation of matter, both symmetries are broken and become positive: Interval > 0, and Number > 0. (Electric charge is zero both before and after the creation of matter, while color is an internal property of baryons, also summing to zero). The positive Interval represents gravitation and time, the positive number charge represents the weak force identity charge and particles. The metric Universe, the Universe of the dimensional conservation domains, responds to the positive number asymmetry by providing an asymmetric temporal entropy drive, an historic conservation domain for information and matter's causal matrix, and a compound conservation domain for both light and particles (spacetime), all through the quantum mechanical and gravitational conversion of space to time.

The universe manifests through the identity charge, as identity provides a basis (an asymmetric foothold of information) for the interaction between the symmetric quark field (the leptoquarks), the leptonic alternative charge carriers (the neutrinos), and the asymmetric mediating field of the IVBs. It is through the identity charge that the IVBs recognize and separate leptoquark from antileptoquark, setting them upon separate and asymmetric decay pathways, breaking the symmetry of their particle-antiparticle pairs. (In a matter-antimatter pair of electrically neutral leptoquarks, one particle's identity charge is neutralized by its antineutrino, allowing it to decay, while (for unknown reasons) the other particle remains intact and unreactive.) Neutrinos are alternative carriers for identity charge, which allows this charge to be conserved or canceled without the presence of antiparticles (antileptoquarks), with their inevitable annihilation reactions. Both the weak force "identity" charge and the gravitational "location" charge are primordial symmetry debts which carry information, whereas the electric charge is more simply an annihilation motivator, while its derivative, the strong force, is only a binding principle. Electric charge and the strong force later become important carriers of information in the compound atomic nuclei of the periodic table, their electron shells, and molecular chemistry. For a more complete discussion, see: "The Formation of Matter and the Origin of Information".

See also: "The Higgs Boson and the Weak Force IVBs" for a further discussion of the weak force in its full energy spectrum.

Weak Force Global and Local Gauge Symmetry

(See: "Global and Local Symmetry in the Weak Force")

The role of the weak force is the most important in nature. It is the weak force that breaks the initial global symmetry of the light universe and matter-antimatter particle pairs, bringing the asymmetric, local, temporal, and causal universe of mass, charge, and gravitation into existence. But for the weak force, the universe would exist only as a cold spatial volume of ever-expanding and cooling electromagnetic waves.

Beyond its initial symmetry-breaking role during the "Big Bang" (the details of which are still not understood), the weak force has the task of regulating the creation, destruction, and transformation of "singlet" elementary particles: the quarks, leptons, and neutrinos.

It is especially important to understand that the weak force always operates in an asymmetric mode. Whereas the electromagnetic and strong forces also create and destroy elementary particles, they do so only in matter-antimatter particle pairs; the weak force exclusively creates, destroys, or transforms single elementary particles, which is the key to its unusual character. In order to perform its transformations, the weak force has to balance and neutralize charges. However, unlike the electromagnetic force, the weak force cannot directly use "real" antimatter particles to balance the charges of matter, for these would cause annihilations, not transformations (the weak force does use *virtual* antimatter particles for this purpose, however). For example, in the weak force decay of a neutron to a proton, the proton's positive electric charge is not balanced by an antiproton, but by the electrically negative electron.

We are nowadays so used to the electron-proton combination of neutral atomic matter that we tend to forget that this is a rather strange combination of particles: three quarks of two different flavors (uud) whose partial electric charges add up to the equivalent of a single leptonic electric charge. The proton's electric charge is balanced by an electron's whole quantum unit negative charge in atomic orbit: 4 particles of three different kinds (ignoring the emitted but nevertheless indispensable electron antineutrino), which all sum exactly to electrical neutrality, and what is more, are exactly equivalent to every other hydrogen atom ever made, regardless of when the particles were created or combined, the expansion of the cosmos, entropy, or any other vitiating (or enhancing) factor. How is such precise uniformity among so many different particles of such different ages and origins achieved? This is the task and the mystery of the weak force, for obviously, charge invariance and symmetry conservation requires nothing less than perfect replication in the creation and transformations of elementary particles and the charges they carry. Elementary particles created today must be the same in every respect as those created during the "Big Bang", or indeed in any past or future time (or place).

The field vectors of the weak force, the IVBs (Intermediate Vector Bosons) are unusual in that they are extremely massive particles, equal to about 80 proton masses, whereas the field vectors of the other forces are massless. It is just the large mass of the IVBs that is responsible for the transformation and creation of elementary particles of precisely equivalent energy, mass, and charge, as compared to any other elementary particle, whenever or wherever created. This equivalence protects charge invariance and hence symmetry conservation during particle transformations.

Although the electromagnetic force creates particle-antiparticle pairs within the local and contemporaneous metric which are obviously symmetry-conserving partners, the weak force must operate without antimatter to produce its transformations, using alternative charge carriers instead (leptons, neutrinos, mesons). How is the weak force to guarantee that these alternative charge carriers are: 1) the precise equivalent in terms of charge of a future, unknown charge partner which is not its antiparticle; and 2) the precise equivalent of all other charge carriers of its own kind? (For example, the electron created in the decay of a neutron to a proton must exactly balance the electrical charge of any other proton, meson, lepton, or other charge-carrying particle, and also be the exact equivalent of any other electron ever created.)

To accomplish this seemingly impossible task without using "real" (rather than virtual) antiparticles, the weak force uses the huge mass of the IVBs to recreate the initial matrix and energetic conditions in which these particles and transformations were first formed during the early moments of the "Big Bang". In other words, the mass of the IVBs tells us that this was the energy density of spacetime when these particles were originally created and freely transformed, one into the other; nothing less than this energy density will suffice to create these particles plus produce these seamless transformations. The IVBs solve their equilibration problems by simply recreating the original conditions; in effect, going back to the original mold in which these particles and transformations were initially created. In is like going back to the Bureau of Standards to recalibrate our instruments, or printing money at the mint from only a single, original plate. This is why the IVBs are strictly quantized masses, so they can only recreate the exact energetic conditions under which these elementary particles and transformations were originally produced. Hence every elementary particle is born under identical conditions, whether in the "Big Bang" of cosmic birth, or subsequently in the "Little Bang" of IVB birth. Charge invariance and symmetry conservation is enforced and protected by the large mass of the IVBs and the Higgs boson. The role of the Higgs boson is to provide a scalar gauge for the mass of the IVBs, ensuring that the environment they create (which is a specific (electroweak) unified force symmetric energy state), and hence the particles they create, is always exactly the same. (See: "The Higgs Boson and the Weak Force IVBs".) The IVB mass is therefore the functional analog of the magnetic field of the photon, or of time in the gravitational field, or of the confining action of the gluons, in that they are all "local gauge symmetry currents" playing a symmetry conservation role of one sort or another. *The charges of matter are the symmetry debts of light*.

Although the IVBs as a group (the W+, W-, and Z) are their own antiparticles, virtual particle-antiparticle pairs of the alternative charge carriers (leptons, neutrinos, mesons) play a major role in facilitating weak force transformations among elementary particles. The large mass of the weak force IVBs essentially forms a bridge between the virtual particle-antiparticle pairs of the primordial dense metric and the "real" (temporal) particles of today, making the charges and particles of primordial "virtual reality" available for the transformation of contemporary "real" particles. The local gauge symmetry "current flow" is both ways: virtual particles transform real particles, and vice versa. One can imagine the IVBs as a sort of time machine or "worm hole" to the ambient conditions of the electroweak force unification symmetric energy state during the "Big Bang" - a time when all such transformations were but the normal course of events, as specific particle identities were subsumed in the generic identities of the electroweak force unity state. Charge invariance and symmetry conservation is maintained and protected in these transformations by the large quantized masses of the IVBs. See various weak force papers cited in the Links section (below) for details of the weak force transformation mechanism.

Row 4 - Field Vectors: The Force Carriers as Symmetry Payments

Row 4: "Retiring the debt, closing the account" - symmetry restoration via the four forces. In Row 4 we list the various ways in which the 4 forces act through their conserved charges to fully repay the original energy, symmetry, and entropy debts incurred by the conversion of free to bound energy during the "Big Bang". All energy, entropy, and symmetry debts are fully repaid by the conversion of bound to free energy, returning matter to its original form of light. This is the payoff for symmetry-keeping and charge invariance - the local, asymmetric, temporal, and relative system of matter is enabled to return to its global, symmetric, timeless, and absolute origin - light. (See: "Currents of Symmetry and Entropy".)

Photons - The Electromagnetic Force and Electric Charge
(row 4, cell 1)

The electrical symmetry debt can be repaid partially by neutralization with alternative charge carriers, or wholly by matter-antimatter annihilation, since unlike gravitation, electric charge is bipolar rather than monopolar (two-way rather than one-way). Whereas the gravitational symmetry debt can only be repaid by the conversion of mass to light, electric charge can be neutralized by its opposite matter charge, as well as annihilated by its antimatter charge. Electric charge acts to prevent the conversion of free to bound energy (as in the suppression of virtual particles via matter-antimatter annihilation reactions). Failing in this (as during "Big Bang" symmetry-breaking), it seems to have little further ability to restore symmetry, other than an eternal readiness to motivate an antimatter annihilation if the opportunity arises. Instead, electric charge contents itself with neutralizing opposite matter charges, confining them to small regions of spacetime, "paying down" its symmetry debt as far as it can. Conversely, gravitation does not act to prevent or suppress the formation of bound energy, but once matter is formed, seems to have a real "agenda" for its ultimate destruction - not "divide and conquer", but "collect and conquer". In this aggressive agenda, we discern the entropic character of gravitation, in contrast to the activity of any other charge or symmetry debt.

The field vector (force carrier) of electric charge is the photon, the quantum unit of light and the electromagnetic force. In the annihilation of matter-antimatter particle pairs, we see the photon protecting its own symmetry. Electric charge is bipolar, consisting of opposite charges which attract each other powerfully over an infinite range of spacetime. The strength of this arrangement is that it permits matter-antimatter pairs to find each other, no matter how great their spatial separation. The weakness of this arrangement is that electric charges can neutralize as well as annihilate each other. It is therefore possible for a composite particle like the baryon to arrange the partial charges of its quarks to a neutral electrical configuration (as in the neutron). It is just such an arrangement that is exploited by the weak force to produce the asymmetric decays of electrically neutral leptoquarks and create an excess of matter in the "Big Bang". Electrical neutrality is the fundamental reason why a composite particle (such as baryons composed of quarks) is necessary if matter is to be isolated from antimatter, breaking the primordial symmetric energy state of light, particle-antiparticle pairs, and the Cosmos.

After "Big Bang" symmetry-breaking and the formation of matter, electric charge can do little to restore the symmetric state of energy because its force is quenched by its ability to neutralize itself. The net electric charge of the Cosmos is zero, both before and after the creation of matter. In chemical reactions, electric charge will drive toward the lowest bound energy state, but chemical releases of energy are insignificant compared with the total energy content of matter. Electrical annihilations of virtual matter-antimatter particle pairs continuously suppresses the manifestation of particles from the "vacuum", maintaining the global symmetry of light and space, at least in our current environment.

Electric charge, however, in the form of the electron shell of atoms and the interplay of electric and magnetic forces, is instrumental in building a negentropic information pathway (with energy supplied mostly by solar gravitation), which culminates in biological systems and the rise of consciousness. In this, electric charge seems to be attempting to reconstruct the original connectivity of light, even if it cannot reconstruct its symmetry. The primordial system of light was not only a wholly symmetric, but also a wholly connected entity. Likewise, life is a completely connected and interactive information system. Electric charge, whose field vector is the photon, can be thought of not only as a debt of light's dimensional (metric) symmetry, but also as a debt of light's dimensional connectivity, the holistic ("holy") character of the primordial energy state. Hence electric charge seems to function as a "memory" of a preexisting state of connectivity and unity as well as of symmetry. Similarly, we may see "beauty" as an emergent expression of symmetry conservation in the "Information Pathway" of biology.

In purely dimensional terms, it is time that reconstitutes for matter the original connectivity of light. Free energy is connected by space, bound energy is connected by time (historic causality, "karma"), gravity connects everything. Time is extracted from space by matter's gravitational field. (See also: "DeBroglie Matter Waves and the Evolution of Consciousness".)

Although it cannot restore symmetry chemically, electric charge nevertheless attempts to reconstruct connectivity in material systems by means of a chemical (molecular) information pathway (connection via biologic information systems in addition to time). For example, biology is nothing if not a web of interconnected information systems, and through the evolution of consciousness, humans have not only become aware of the essential connectivity of the Cosmos, both intuitively and rationally, but are now engaged in the process of extending this biological web of connection between the planets of our solar system, and perhaps on into the galaxy. Significantly, through humanity, the biological "Information Pathway" (see table) has converged with the abiotic gravitational symmetry conservation pathway, converting bound to free energy through hydrogen fusion and the nucleosynthetic process. Hence, if we actually succeed in annihilating ourselves with hydrogen bombs, we can always blame the universal symmetry conservation agenda rather than our own aggressive stupidity. (See also: "Chardin: Prophet of the Information Age".

Gravitons - Gravitation

(row 4, cell 2)

(See: "A Description of Gravitation")

> Charge conservation acts as the "credit card" of the Cosmos - "buy now, pay later", with gravity paying the entropy-"interest" on matter's symmetry debt by creating bound energy's time dimension via the annihilation of space. The notion of charge conservation would be moot in the absence of time. On planet Earth (for example), gravity only pays the entropy "interest" on matter's symmetry debt, since the "principle" of this debt (mass or bound energy) is never reduced thereby, nor is the gravitational field itself ever reduced. However, in our Sun (for another example), gravity pays down the "principle" of matter's symmetry debt by the conversion of bound to free energy, reducing both the mass of the Sun and its associated gravitational field. In Hawking's "quantum radiance" of black holes, gravity completely pays off matter's symmetry debt by (eventually) completely converting the hole's mass to light. The gravitational field vanishes when bound energy and its associated symmetry debt disappears. The consequent dissolution of the gravitational field tells us it is no longer needed because its symmetry-conservation role is fulfilled.

If we are to believe Einstein, gravitons, the field vectors of gravitation, must connect directly to the dimensional structure of spacetime. This connection is attractive only, without a repulsive counterpart, as in electricity. The effect is to "warp" or "bend" spacetime, an action which is due to the intrinsic motion of time dragging space into the historic, temporal domain. The "warpage" affects time and space in metrically equivalent terms. It may be difficult to imagine how anything could connect to something so intangible as a dimension, yet this is certainly the best explanation we have. And the dimensions are not so intangible when we encounter them through gravitational or inertial forces ("g" forces felt during acceleration); the intrinsic motion of time, the intrinsic motion of light, and gravitation itself can also be considered inertial forces in that they are all dimensional (metric) expressions of entropy, symmetry, or energy conservation.

A dynamical view of gravitational action is allowed by Einstein's equations, via his own "Equivalence Principle". We are free to view a reference frame as either at rest in a static negative gravitational potential (as on the surface of the Earth), or as accelerated in spacetime by an equivalent positive motive force (as in a rocket ship). Hence we can view gravitation as the accelerated motion of spacetime itself, rather than as a static, "warped", or "curved" metric field. It seems to me this dynamic view offers a physically simpler way to visualize gravitational action, and is heuristically more fruitful, leading to other insights as well.

The equivalence principle follows from the notion that we cannot distinguish between moving ourselves through spacetime (acceleration), or spacetime moving itself through us (gravitation). In the dynamic view, all objects fall with the same acceleration not because the static gravitational potential is the same but because they are all co-movers in the same accelerated flow of spacetime. Similarly, the local metric is "warped" simply by the physical flow of space (caused by time's intrinsic motion); co-movers with the flow (free fall, orbit) are of course unaware of its motion - all the ordinary gravitational effects are as readily explained by one view as by the other - if we restrict our view to small scales and local effects. (See: "Extending Einstein's Equivalence Principle".)

"Quantum Radiance" and Black Holes

Like the other charges of matter, gravitation has a symmetry debt to pay, and like the other charges, if gravitation cannot pay off the debt outright, it will always move in that direction by at least "paying down" the debt as much as possible. Since an atom or a planet can have the same center of mass or "location", the gravitational concentration of massive particles reduces the scatter of individual "location" charges, confining them to as small a volume of spacetime as physically possible. (The attractive principle of gravitation (-Gm), however, is simply the collapse of space caused by the intrinsic motion of time. See also: "The Conversion of Space to Time".) According to Roger Penrose, this collecting activity maximizes the entropy of the system. (See: *From Eternity to Here* by Sean Carroll, Dutton 2010, page 302.) However, in my view, this collecting activity is an expression of gravity's characteristic negative spatial entropy drive, and is a stepping stone on the pathway of gravity's symmetry conservation agenda. If enough mass is accumulated, the fusion reactions of the nucleosynthetic pathway are initiated, converting a portion of the bound energy to light, a direct payment of the symmetry (and entropy) debt. However, nucleosynthesis can only go so far, as baryon "number" conservation prevents the great bulk of any stellar mass from converting to light. Nevertheless, gravitation drives on, collapsing the electron shells of atoms in "white dwarfs", and finally driving this "electron sea" into the protons, forming neutron stars, essentially gigantic atomic nuclei held together by gravitational forces. Still unsatisfied, if enough mass is present, gravitation collapses even nuclear matter to the singularity of a black hole, surely the most bizarre and fearsome object in the universe.

Matter simply falling into a black hole can convert much more of its bound energy to radiation than through nucleosynthesis (more than 20% vs 1% - see: *Sky and Telescope*, Jan. 2007, pages 43-47). This includes extracting energy from the rotational energy of the hole, from the gravitational potential energy of highly accelerated particles (including any relativistic increase in mass), and even from the binding energy of nuclear particles, which the intense gravitational field of the hole replaces.

In the creation of a black hole, gravitation reaches its symmetry-conservation goal, for as Stephen Hawking has shown, through the principle of "quantum radiance" the total mass of a black hole will eventually be converted to light. The defining feature of a black hole is that the gravitational acceleration of spacetime reaches the equivalent of the intrinsic motion of light. As in the venerable saying, "the extremes meet": matter began as light with intrinsic motion c; matter ends by itself achieving intrinsic motion c through the gravitational acceleration of spacetime, a total reversal of the roles of intrinsic motion and spatial vs temporal entropy. The full circle of the black hole returns matter to light again, an amazing story of purposeful and relentless symmetry conservation which no one would believe if Einstein's and Hawking's mathematics were not there to prove it (although the early stages of this process are plainly before our eyes in our own Sun).

Because the spatial entropy drive of light (intrinsic motion c) has greater symmetry than the one-way historical entropy drive of time (intrinsic motion T), Hawking's quantum radiance demonstrates that even the symmetry of entropy is conserved. It is symmetry conservation at every level and the ultimate expression of Noether's theorem that drives the evaporation of black holes. The event horizon of a black hole is a temporal entropy surface (the Bekenstein-Hawking theorem), displacing space somewhat (but not exactly) as a ship displaces water, providing a physical demonstration of the gravitational conversion of space and the drive of spatial entropy to time and the drive of historical entropy.

In thermodynamic terms, the conversion of light's entropy drive (light's intrinsic motion) to matter's entropy drive (time's intrinsic motion) reaches a limiting case in the black hole. Because at the Schwarzschild radius the inflow of space is already at velocity c, it is not physically possible to simply continue increasing the intensity of the field when more matter is added to the hole. Therefore, the only accommodation possible for (the entropy requirements of) further mass inputs is to increase the size of the surface over which this maximum spatial flow is realized, resulting in the Hawking-Bekenstein theorem relating the entropy of a black hole to its surface area. Therefore black holes are somewhat larger than one might otherwise assume.

(If two black holes of equal mass merge, the result will be a black hole with (at least) twice the surface area, not twice the volume.) Paradoxically, this effect does not reduce the critical density of the hole as it grows larger, because we are dealing with a time surface, not a spatial volume. Space is displaced by time, not by a competing spatial volume, which is where the ship displacement analogy fails. Gravity has replaced the 3-D geometry of space with the 2-D geometry of history.

Recall that light is a 2-D transverse wave whose intrinsic motion (entropy drive) "sweeps out" a third spatial dimension. Hence the volume of space is light's entropy expression. It is just this spatial volume which gravity has squeezed down to a flat surface, converting the 3-D spatial entropy of light entirely to the 2-D temporal entropy of matter. Just as the 2-D wave of light is converted to a 3-D volume of space by the intrinsic motion of light's entropy drive, so too is the 1-D time line converted to a 2-D historical surface by the intrinsic (entropic) motion of time. The black hole is telling us that historical entropy is actually 2-D, not 1-D as we might suppose. Hence we actually live in a 5-D Cosmos of historical spacetime, not 4-D, as is commonly supposed. It can be readily appreciated that historic time, which encompasses the vast domain of the past and rolls ever onward into the future, should have a 2-dimensional representation (many simultaneous events moving together in one-way time). (See: "The 'Spacetime Map' as a Model of a 5-dimensional Holographic Universe".)

It naturally takes more "space" to store historical entropy than we might expect (the event horizon is larger than we might think), because the interior of the enclosed spherical volume is not available for this purpose, only the surface of the event horizon can be used - because of the limitations imposed upon the gravitational spatial flow by "velocity c", as mentioned earlier in the "water pipe" analogy. The total raw energy of the black hole remains proportional to its mass, while the entropy of its energy content is proportional to the surface area of the event horizon: the 3-D spatial entropy of light is gravitationally crushed and transferred to the 2-D historical entropy of matter. This is the extreme example of the gravitational metric of time and matter completely replacing the electromagnetic metric of space and light - just as gravity replaces the roles of all the other forces in the black hole.

If the mass of the Earth were reduced to the density of a black hole, it would have an event horizon approximately equal to the size of a Ping-Pong ball. I assume that the surface area of this "Ping-Pong ball" represents the actual size of the "tangential" contact point between historical spacetime and the entire mass-energy of planet Earth. (The fact that this contact point is greater than zero means that the temporal entropy drive of matter will actually have a very small vitiating effect upon atoms, as possibly realized through "proton decay".) (See: "Proton Decay and the 'Heat Death' of the Universe").

Gluons - The Strong Force: Fusion and Proton Decay

(row 4, cell 3)

In addition to its important role in confining quarks to elementary whole-quantum charge units, the strong force contains an important internal symmetry. Each quark carries one color charge, which it swaps with its neighbors in a ceaseless round-robin exchange by means of an internal field of "gluons". Because the gluon field is composed of color-anticolor charges in every combination, it sums overall to zero color, a crucial charge symmetry.

Physically squeezing the quarks together has the effect of summing up the gluon field, so that as quarks crowd together, the strong force relaxes and the quarks move more easily with respect to each other, an effect known as "asymptotic freedom" (Politzer, Gross, and Wilczek: 2004 Nobel Prize for Physics). "In the limit", if the quarks are fully compressed, the color charge (which is otherwise conserved) sums to zero and vanishes. This is the charge configuration of the leptoquark, and is the condition of "color symmetry" (color = 0) which is necessary for proton or leptoquark decay. Usually, quarks repel each other electrically and through other quantum mechanical forces (Pauli's "Exclusion Principle"); as quarks spread apart (increasing the threat to symmetry conservation and charge invariance posed by their fractional charges), the color force becomes explicit, limiting their expansion. Because the color charge is conserved, the weak force cannot cause baryon decay while the color charge is explicit (neutrinos do not carry color charge). But if for some reason the color charge should self-annihilate (as in the extreme pressures of the Big Bang, a black hole, or via the "X" IVB; or perhaps simply by a quantum-mechanical random fluctuation in the positions of the three quarks), the leptonic decay of a baryon can go forward. It is this effect that allows the weak force decays of electrically neutral leptoquark-antileptoquark pairs during the birth of the Cosmos.

"In the limit" (of pressure, compaction, and size) the color charge vanishes. This limit probably translates physically to compacting the quarks of a baryon to "leptonic size", eliminating any threat to symmetry-keeping by the quark fractional charges. In this condition, with no color charge present, a baryon is indistinguishable from a heavy lepton, reverting to its ancestral form, the "leptoquark". When fully compressed, the leptoquark is a lepton and the color charge is implicit; when the pressure is relieved, the quarks expand, color charge becomes explicit, and the leptoquark becomes a baryon. As a lepton, the leptoquark must have an associated neutrino, but as a baryon, this neutrino cannot cancel the explicit color charge. Thus the baryon is stable against "proton decay" in its normal (expanded) state. Only when the quarks are fully compressed, vanishing the color charge, does the baryon return to its leptonic ancestral state, and proton decay becomes possible with the emission of a leptoquark neutrino.

Presumably, all baryons have one and the same "number" charge, as all derive from the same leptoquark ancestor, and all must revert to this same high-energy form to decay, resulting in the extraordinary stability of the proton. Other than the hypothetical superheavy "X" IVB, it seems likely that only the gravitational pressures of a black hole can provide sufficient symmetrically applied force to routinely cause proton decay. If this is so, then the interior of black holes may consist of nothing but gravitationally trapped light, a condition strangely reminiscent of the gluons or "sticky light" trapped within a baryon. (While a neutron star is like a gigantic gravitationally bound compound atomic nucleus, a black hole represents the next level of simplification, a gigantic gravitationally bound single baryon.) Trapped light would solve the question of the infinite compressibility of matter at the central singularity, as there is no quantum-mechanical limit to the superposition of photons. (See also: "A Connection Between 'Inflation' and the 'Big Crunch'")

The strong force (color field) acts to protect light's symmetry by confining quarks to whole quantum unit charge combinations, and restores light's symmetry through self-annihilation and proton decay. The strong force (meson field) initiates nuclear fusion, resulting in the creation of heavy elements in the nucleosynthetic pathway of stars, and the conversion of nuclear binding energy to light. This pathway, however, is relatively short and ineffective, as only a small fraction of the energy stored in baryons can be released through nuclear fusion. Proton decay converts all nuclear mass to light, but the process is so rare that the proton, in human terms, is virtually eternal. We owe the stability of matter to the conserved color charge of the strong force, the weakness of gravity, and the huge mass-energy barrier of the "W" and "X" IVBs. But the seeds of its own destruction are contained within the baryon, through the principle of "asymptotic freedom" and the potential for self-annihilation of the color charge. (See: "The Half-Life of Proton Decay and the Heat Death of the Universe.")

The Weak Force IVBs: Fission, Identity Charge

(See also: "Introduction to the Weak Force".)

(row 4, cell 4)

Because it is the weak force which breaks the symmetric state of energy in the "Big Bang" and brings the material Universe into existence, we might not expect this force to be particularly active in returning the material system to symmetry. Yet, the force that creates matter can also destroy matter, and it does so in several ways - through the decay of heavy particles to their "ground state", through the fission of heavy compound nuclei (radioactivity), through contributions to fusion in the nucleosynthetic pathway of stars, and through the process of proton decay, for which it provides the annihilating identity charge (the leptoquark antineutrino) as well as the "X" IVB. (See: "The Particle Table".)

When we consider an elementary particle, such as the electron (e-), we often forget that (in addition to spin) this particle carries two charges, electric charge and "identity" (or "number") charge. The electric charge is indicated by the negative sign, the identity charge is indicated by the "e" (this charge is sometimes also referred to as "flavor"). We say that identity charge is "hidden", or carried in implicit form, by the massive electron, but is revealed in its explicit, "bare", and nearly massless form as the electron neutrino. (Whether or not the neutrino is actually massless has little to do with its symmetry debt of "identity". Most charges are in fact carried by massive particles). Usually the "identity" charge is simply called lepton or baryon "number" charge (or even "flavor" charge), which obscures the true meaning of this charge. If "number" charge adequately described its function, then the number charge of the electron would also serve as the number charge of the muon and tau; but as we have discovered, there is a specific and distinct neutrino associated with each member of the elementary leptonic spectrum, so the charge is more accurately described as "identity". Moreover, we can readily assign "identity" as the plausible symmetry debt of light's "anonymity", with a sensible function to perform in annihilation reactions (facilitating the choice of the correct antimatter partner), arguments and contact with Noether's theorem which we cannot make for a generalized "number" charge.

It is at first a curious fact, and then after reflection an obvious one, that the "identity" charge is the key to manifestation. It is identity that brings matter into existence as the principle or "cardinal" symmetry debt. But then, how could it be otherwise? Identity is the essence of asymmetry, the key ingredient of information that must be isolated from the symmetric field of energy if manifestation is ever to occur. (See also: "The Weak Force "W" Particle as the Bridge Between Symmetric (2-D) and Asymmetric (4-D) Reality".)

In addition to the mesons (which function to transform baryons in both the strong and weak forces), the leptonic field of elementary particles functions as an alternative charge carrier, both for the composite field of the quarks and hadrons, and for other leptons. The massive leptons function as alternative carriers of electric charge, the (nearly) massless neutrinos function as alternative carriers of identity charge, the mesons function as alternative carriers of quark spin, flavor, color, and partial electric charges. Without these services, the quark field could not manifest, since in the absence of alternative carriers, quarks could only balance their charges with antiquarks, and they would remain forever locked in mutually annihilating particle-antiparticle pairs. Without neutrinos, the massive leptons would likewise remain locked in their particle-antiparticle pairs, themselves lacking an alternative carrier of identity. Hence it is that the neutrino, the least of all particles, becomes the "mouse which nibbles the lion's net", providing a material, alternative, and temporally conserved carrier of identity charge, and through this service (the translation of a massless, atemporal symmetry feature into a massive, temporal charged particle), unleashes the information potential of the Cosmos. There is a deep analogy between nature's use of charged particles to carry symmetry debts, and the human invention of language: both are abstractions of information. This is another reason why mathematics is so successful in representing physical systems - it is one abstract language reflecting another. (See: "The Weak Force: Identity or Number Charge".)

Just as we see the biological information pathway of the electromagnetic force evolving to reestablish the primordial connective unity of light (communications, mutualism, social systems, ecosystems), and emergent forms of symmetry ("beauty") throughout living systems, so we also see through the rise of consciousness and the emergence of complex organisms with definite individuality and personality, the reemergence and exploration of weak force "identity" in the biological realm.

For a further discussion of the weak force IVBs (and associated Higgs bosons) in their full energy spectrum, see:

(**End Table**)

Go to Summary Section (Part III)
Go to Part I

Links:

Introduction to the Papers

Section I: Unification
Section II: Gravitation
Section IV: Introduction to the Weak Force
Section VII: Entropy
Section VIII: General Systems, Complex Systems
Section IX: Symmetry: Noether`s Theorem and Einstein's "Interval"
Section XIII: The Solar Archetype
Section XVI: Introduction to the Higgs Boson

Weak Force Papers:

The "W" Intermediate Vector Boson and the Weak Force Mechanism (pdf file)
The "W" IVB and the Weak Force Mechanism (html file)
The Weak Force: Identity or Number Charge
The Weak Force "W" Particle as the Bridge Between Symmetric (2-D) and Asymmetric (4-D) Reality
The Strong and Weak Short-Range Particle Forces
The "Higgs" Boson and the Spacetime Metric
The "Higgs" Boson and the Weak Force IVBs: Part I
The "Higgs" Boson and the Weak Force IVBs: Parts II, III, IV
"Dark Matter" and the Weak Force

The "Tetrahedron Model" in the Context of "Global and Local Gauge Symmetries":

Global-Local Gauge Symmetries and the "Tetrahedron Model"
Global-Local Gauge Symmetries: Material Effects of Local Gauge Symmetries
Global-Local Gauge Symmetries of the Weak Force
Global-Local Gauge Symmetries in Gravitation

General Topics:

Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part I
Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 2
Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 3 (summary)
Principles of the Unified Field Theory: A Tetrahedral Model
(Postscript and Commentary on paper above)
Synopsis of the Unification Theory: The System of Spacetime
Synopsis of the Unification Theory: The System of Matter
Light and Matter: A Synopsis
The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison

Gravitation

Entropy

Cosmology

Tables and Diagrams:

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Go to: "Symmetry Principles of the Unified Field Theory: Part 1"
Go to: "Simple Table of the Unified Field Theory, Rational Mode"
Go to Summary Section (Part III)