A Short Course in the Unified Field Theory

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home page

Knowledge comes by taking things apart: analysis. But wisdom comes by putting things together. - John A. Morrison

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Abstract

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. *The charges of matter are the symmetry debts of light*. Charges produce forces which act to return the material system to its original symmetric state, paying matter's symmetry/entropy debts. Payment is exampled by annihilation reactions (electromagnetic force); radioactivity (fission), fusion, particle and proton decay (weak and strong nuclear forces); the nucleosynthetic pathway of stars, and Hawking's "quantum radiance" of black holes (gravitational force). 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 conservation of energy, symmetry, entropy, and causality, plus the requirement of primordial symmetry-breaking followed by the maintenance of charge invariance (including the phenomena of "local gauge symmetry"), are all key conceptual elements in the formulation of a Unified Field Theory.

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

Introduction

Our Universe consists of a mixture of free and bound electromagnetic energy (light and matter), set in gravitational spacetime, governed and regulated by various conservation laws and forces which determine both its origin and destiny. This paper presents an overview of the Unified Field Theory in its qualitative - rather than quantitative - form. The focus is upon why the Universe is and must be the way we find it, a

Cosmos whose life-friendly parameters are apparently a random sample of the "Multiverse", and whose daily workings are to be understood in terms of four interrelated conservation laws: energy, entropy, symmetry, and causality (law of cause and effect). In this general treatment, we are concerned with entropy only in its most primordial aspect, expressed as the intrinsic motions of light, time, and gravitation. As for symmetry, we recognize two epochs: one (short and unfamiliar) at high energy, governing the devolution of matter from light during the "Big Bang"; another (long and familiar) at low energy, governing the evolution of matter back to light.

The electromagnetic constant, "velocity c", regulates ("gauges") the symmetry of the spacetime metric and the entropy drive of free electromagnetic energy (the intrinsic motion of light) - among many other critical functions. The gravitational constant "G" regulates the conversion of space to time, determining how much space must be annihilated per second to provide the historical entropy drive of bound electromagnetic energy (the intrinsic motion of time), for any given mass (Gm). All conservation laws stem from and serve energy conservation, the 1st law of thermodynamics. If we are to characterize our presentation with a single sentence and overarching principle, it is with a paraphrase of "Noether's Theorem": *the charges of matter are the symmetry debts of light*.

This paper is not intended to stand alone. For an in-depth discussion of the many concepts surveyed in this article, the reader must see the supporting papers referenced on my website, where I employ an evolutionary and a General Systems approach to the subject. (See: "Symmetry Principles of the Unified Field Theory" (part I); (part II).)

Any manifest universe must be capable of symmetry-breaking plus complete self-conservation - that is, able to escape its symmetric beginning, but also able to recycle itself, returning to its origin under its own power, initiative, and self-contained conservation principles - as a boomerang returns to the hand that throws it. Thus we find that matter is actually a bound form of light, enabling the material universe - which originates as light - to return to light (free vs bound electromagnetic energy). This is also why the four forces - which constitute a final pathway for matter back to light - must also be the initial pathway which leads from light to matter. (See: "The Higgs Boson and the Evolutionary Eras of the Cosmos".)

The Tetrahedron Model

See: The Four Conservation Principles governing the transformation of light into matter and vice versa.
See: The "Tetrahedron Model".

1) Energy Conservation: conservation of raw energy. Energy may be transformed but neither created nor destroyed. In the "Big Bang", the raw energy of light (free electromagnetic energy) is transformed to the raw energy of matter and kinetic energy ("mass" -- bound electromagnetic energy): hν = mcc (DeBroglie's equation).

2 Entropy: c, G, T - intrinsic motion of light, gravity, and time. The dimensions are energy conservation domains created by the primordial entropy drives (intrinsic motions) of free and bound electromagnetic energy. The intrinsic motion of light creates, expands, and cools space; the intrinsic motion of time creates, expands (ages), and dilutes history, and decays matter; gravity mediates between the entropic domains of space and history, creating time from space (as on earth) and vice versa (as in the stars). Entropy is the principle that allows us to use and transform energy without violating energy conservation. The intrinsic motions of light and time are metrically equivalent "infinite" velocities (primordial entropy drives) protecting energy conservation. (See: Spatial vs Temporal Entropy".)

3) Symmetry Conservation (and symmetry-breaking): Noether's Theorem. *The charges of matter are the symmetry debts of light*. Symmetric light produces asymmetric matter (through primordial symmetry-breaking weak force processes separating matter from antimatter). In consequence of symmetry-breaking,

matter bears charges (symmetry debts) causing forces (forces represent the demand for payment of the symmetry debts); forces act to return matter to light, paying matter's symmetry debts, as required by Noether's Theorem. One charge exists for each force, including gravity ("location" charge). The symmetry of light is conserved no less than the raw energy of light. Charge and symmetry conservation allows the transformation of energy into "information" - just as entropy allows the transformation of energy into "work". (See: "Symmetry Principles of the Unified Field Theory".)

4) Causality-Information: Law of Cause and Effect - "Karma", history, historic spacetime. Atoms, matter, mass. Free electromagnetic energy is transformed into bound electromagnetic energy: $E = h\nu$; $E = mcc$; $h\nu = mcc$; (Planck; Einstein: DeBroglie). Matter is local, causal, temporal and massive, bearing charges, information, producing a gravitational field proportional to its bound energy (Gm), and moving with an intrinsic (entropic) historical motion T (time). (See: "The Time Train").) Light is non-local, acausal, atemporal, and massless, bearing no charges or information, producing no gravitational field, and moving with an intrinsic (entropic) spatial motion c ("velocity of light"). History is the temporal analog of space. From information, charge, and energy, matter evolves life through time, an inevitable chemical reaction guided by the 4x3 fractal algorithm of the Cosmos (See: "Nature's Fractal Pathway"). The role of charge and information is to guide the return of matter to light, and to produce life, the energy form by which the universe knows and experiences itself, and eventually fulfills its creative potential. (See: "The Human Connection".)

The Conservation and Invariance of Charge

The transformation of light to matter and back again (symmetry-breaking and symmetry restoration) must satisfy specific conservation rules, including - in our case but not generally - "life friendly" physical constants (the low value of G in our cosmos would be an example), allowing (among other things) the slow return of the material system to light, providing time for the evolution of life. The extended time interval between the initiation and destruction of our universe requires compensating or "holding" actions by the conservation forces, maintaining the material system in a state of perpetual readiness to return to light (ready to pay or redeem upon demand the symmetry debt of light as carried by matter), and this despite being embedded in a hostile, temporal environment. Examples of obstacles to conservation in our material world include: an environment of relative rather than absolute motion; a metric dominated by G rather than c; massive rather than massless forms of energy; fractional rather than unitary charges (in the quarks); particles with differing identities or "flavors" (leptons, baryons) rather than "anonymous" identical particles (photons). In sum: temporal, local, causal, massive, and charged particles (including fractionally charged particles) producing gravitational fields, relative motions, with diverse identities rather than atemporal, non-local, acausal, massless, uncharged anonymous particles producing no gravitational fields and having intrinsic absolute motion (light).

In addition to actually paying the symmetry debts represented by charge, the 4 forces of physics also conspire to maintain the invariance of charge and other conserved parameters despite the imperfections of the material environment (the "holding" actions mentioned above), and in this role are designated "local gauge symmetry" forces. (See: "Global vs Local Gauge Symmetry and the Tetrahedron Model": Part I.) It will be appreciated that the maintenance of charge invariance is a necessary corollary of charge conservation, and that this is not a trivial matter in our imperfect world of matter, time, gravitation, relative motion, and entropic expansion. Thus, in the electromagnetic force we find magnetism, whose strength varies in proportion to the relative motion of electrically charged particles, maintaining thereby the invariance of electric charge. The relative motion of material objects in spacetime likewise produces "Lorentz Invariance", the co-varying effects of time and space described by Einstein's Special Relativity, which operates to protect causality, velocity c, and the invariance of the "Interval". The Doppler effect resulting from the relative motion (or the gravitational field) of a source of light is a related example in which the frequency of light changes while the velocity of light remains invariant. The permanent

confinement of fractionally charged quarks by gluons and color charges, and the huge mass of the Intermediate Vector Bosons of the weak force (necessary to insure invariance during the production of single elementary particles) are further expressions in the nuclear forces.

Time itself is an alternative form of entropy drive produced by gravity (via the annihilation of space), to compensate for matter's lack of intrinsic spatial motion and the loss of light's non-local distributional symmetry (when light is transformed to immobile, massive particles). Because the energy content of massive particles varies with their velocity, the relative motion of matter would be impossible without a time dimension to accommodate such variable energy accounts. The historical domain likewise exists to accommodate the causal relations of matter, as also necessitated by energy conservation.

Symmetry-Breaking

The primordial requirement of symmetry-breaking (the escape of matter from light and annihilating particle-antiparticle pairs) followed by charge conservation has left an indelible impression upon the composition and character of the atomic system, including charge quantization, the fractional charges of the quarks, and the division of atomic matter into mass-carrying quarks (nuclear material) and charge-carrying electrons and neutrinos (hadrons vs leptons). The three-family structure of the quarks and leptons may be a further example.

The neutrino is an alternative form of "identity" charge produced by the weak force to compensate for the loss of the photon's symmetric "anonymity" by the individually distinguishable spectrum of massive elementary particles. (See: "The Particle Table".) The alternative identity charges of the neutrinos (including their "handedness") are crucially necessary to allow "Big Bang" symmetry-breaking and the escape of the material system of quarks and electrons from the otherwise mutual destruction of annihilating matter-antimatter particle-pairs. The leptonic families in general act as alternative charge carriers for the electric and identity charges of the mass-carrying quarks (or for each other) - the proton/electron pair, and the electron/electron neutrino pair are examples. (See: "Identity Charge and the Weak Force".) The entire elaborate mechanism of the weak force (including the Higgs boson and the massive IVBs) is dedicated to the production of invariant, single elementary particles in any time or place - particles which can seamlessly swap places (if necessary) with those created during the "Big Bang". (See: "The Higgs Boson and the Weak force IVBs".)

The gluon field of the strong force is required to maintain the wholeness of quantum charge units despite the fractional charges borne by quarks. (See: "The Strong Force: Two Expressions".) The quark fractional charges are in turn necessary to the initial symmetry-breaking of the primordial particle-antiparticle pairs (since they allow electrically neutral quark combinations). The asymmetric production of matter from light during the "Big Bang" is thought to originate with the (unexplained) asymmetric decay of leptoquark-antileptoquark pairs, resulting in a tiny residue of matter. (See also: "The Origin of Matter and Information".) It has been suggested that the three-family structure of the quarks and leptons may be a necessary component of the primordial asymmetry between matter and antimatter. (See: Frank Close: *Antimatter*, 2009, Oxford Univ. Press.)

Charge Now - Pay Later

The material system is conserved in spite of its imperfection; charge conservation and charge invariance assure that the symmetry debt of light will be paid in full, eventually, at some future time. The grandest expression of cosmic dedication to charge and symmetry conservation is the gravitational creation of time from space, for without the time dimension, charge conservation for the future payment of symmetry debts would have no meaning. Our cosmos is a "buy-now, pay-later" system of charge conservation and symmetry debts which runs on the credit card of gravity. The entropy-interest on the symmetry debt of

matter is paid by gravitation; gravity creates time from space (gravity annihilates space, extracting a metrically equivalent temporal residue), decelerating the cosmic expansion in consequence. Hence the entropy-energy to produce matter's time dimension and the expansion of history is withdrawn from the expansion of space, which in turn is driven by the intrinsic (entropic) motion of light. It is therefore the expansive entropic energy of light's intrinsic motion and spatial domain which ultimately pays for the expansive entropic energy of matter's historical dimension, just as the raw energy of light pays for the raw energy of mass (hv = mcc). The recently observed "acceleration" of the universal spatial expansion is caused by the relaxation of the cosmic gravitational field, as mass is converted to light by various astrophysical processes - which may include the decay of "dark matter". (See: "A Spacetime Map of the Universe".) "Every jot and tittle of the law will be fulfilled"; and "Not a sparrow falls but the Father knows" (intuitive expressions of the operation of conservation law, anciently recognized).

Causality: Time Sequence and Energy Conservation - Metrics and Gauges

In the "Tetrahedron Model" we attempt to characterize reality in its most essential features - much as the Greeks did with their "four elements" - except the present effort is in a "scientific" or rational mode. The "trinity" of conservation laws which apply to the transformation of light (free electromagnetic energy) into matter (bound electromagnetic energy) are conventional "Standard Model" or "textbook" principles: 1) the Conservation of Energy (1st law of thermodynamics); 2) Entropy (2nd law of thermodynamics); 3) the Conservation of Symmetry (Noether's Theorem). Our 4th and final choice is for our general characterization of matter, the product of the transformation of free, massless electromagnetic energy to a bound, massive, atomic form. Two possibilities suggest themselves for conservation laws or principles which are uniquely associated with or uniquely characterize matter: 1) Causality (law of cause and effect) - causes must precede effects and every effect must have a cause); and 2) Information (which also is associated with a conservation law in Quantum Mechanics to the effect that information cannot be destroyed) (see Leonard Susskind's book: *The Black Hole War,* 2008, Little, Brown, and Co.). Of these two I have chosen causality, because causality implies information but the reverse in not true, at least not to my thinking; therefore, the causal law is the stronger and more encompassing principle. Not that we can do without information - we must have it as a corollary to causality. We cannot have a causal law unless we also have the information which identifies both the cause and the effect (in Quantum Mechanics part of the information may be hidden or "unavailable" in "complementary" dyads such as position/momentum or energy/time). Therefore, when we characterize matter with causality we will sometimes specifically append information (as Causality-Information), but we will always imply that causality carries with it the associated concept of information. Information becomes a primary conceptual principle in biological systems: biology is the information pathway whereby the Cosmos achieves self-awareness and explores its creative potential. (See "The Information Pathway".)

Gravity and Time

Causality implies the existence of a temporal metric which orders the linear sequence of events, but this metric must be created with matter since the time dimension does not exist for non-local light. Time and (specific) place go together, and the task of creating a time dimension for matter falls to gravity. All massive energy forms must produce a gravitational field because gravity is how matter produces its time dimension. As Einstein realized, time is a locally generated, rather than a globally generated, component of the metric. (All bound energy forms carry the gravitational "location" charge (Gm), which is the symmetry debt of the non-local distribution of light's energy - a spatial distribution symmetry obviously broken by local concentrations of immobile matter and mass-energy. Light's non-local symmetric energy state is gauged by "c", and matter's gravitational "location" charge is gauged by "G"). Gravity produces time by the annihilation of space and the extraction of a metrically equivalent temporal residue. Time itself is the active principle of the gravitational "location" charge. (See: "The Conversion of Space to Time".)

Time is necessary for bound energy for numerous reasons of energy conservation. The energy content of matter varies with its relative motion, and this requires a time dimension for accounting purposes. Causality also is required by energy conservation: causes must precede effects or there will be no source of energy to produce the effect. The intrinsic motion of time is also the historical entropy drive of bound energy - transformed by gravity from the spatial entropy drive of free energy (the intrinsic motion of light). Gravity is the force which mediates between these two universal, primordial entropy drives, one spatial for free electromagnetic energy, and one temporal for bound electromagnetic energy. (See: "A Description of Gravitation".) Gravity is weak because it creates only enough time to satisfy the entropic drive of matter's ephemeral "present moment" - not matter's associated historical domain. (See: "Proton Decay and the 'Heat Death' of the Cosmos".)

The gravitational, temporal metric of matter is superimposed upon the spatial metric of light, producing a composite metric of spacetime which governs our compound world of free and bound electromagnetic energy. (The "metric" is the measured relationship between the spatial and temporal dimensions. In our electromagnetic system of spacetime, as gauged (regulated) by "velocity c", one second of temporal duration is metrically equivalent to 300,000 kilometers of distance.) The spatial universe expands more slowly due to the presence of matter and its associated gravitational field - historic spacetime expands more slowly than pure space, while a gravitational version of "Lorentz Invariance" protects the local value of velocity c, causality, and the "Interval". Clocks run slow and meter sticks shrink in a gravitational field; there is also a gravitational Doppler effect. However, in free fall or orbit, clocks and meter sticks are unaffected. Measurements of velocity c at any given location within a gravitational field (or elsewhere) always give the same invariant value, because local clocks and meter sticks are affected in such a (covariant) way as to maintain the invariance of c and safeguard the "Interval" and the principle of causality (and hence also energy conservation). There can only be a single metric and hence a single value of c (the metric gauge) at a single location in spacetime. Comparative "vertical" measurements, however, (higher and lower in a gravitational field) will reveal differences in the metric scale due to differences in the strength of the gravitational field. The gravitational flow can be thought of as a response by spacetime to the "warped" metric in the direction of "cheaper" energy (due to the slower time scale). From another perspective that amounts to the same thing, I prefer to think of the gravitational flow as caused or induced by the intrinsic motion of time itself: *a gravitational field is the spatial consequence of the intrinsic motion of time*. (See: "The Conversion of Space to Time".)

In weak fields (as on planet Earth), gravity only pays the entropy "interest" on the symmetry debt carried by matter, converting space to time, providing an alternative entropic dimension (history) in which charge conservation can be realized over an indefinite temporal scale. In stronger fields, gravity also pays the "principal" of matter's symmetry debt, converting mass to light, as in our Sun (partially), and in Hawking's "quantum radiance" of black holes (completely). Symmetry debts can be paid at any future time - unlike energy or entropy debts, which must be paid immediately. The second symmetry-conserving reaction reverses the effect of the first entropy-conserving reaction, as when mass is converted to light, matter's associated gravitational field and time dimension are also converted to light's intrinsic motion. (See: "Gravity, Entropy, and Thermodynamics". See also: "Extending Einstein's Equivalence Principle".)

Summary

Many if not most of the known characteristics of the forces can be accounted for from the various conservation and other requirements which must be met by any universal material system which successfully manifests (can break symmetry initially, but nevertheless observes conservation and eventually returns to its origin). The ultimate unity of the forces subsists in the fact that matter is a bound state of transformed and conserved light, and all matter's charges - and hence their associated forces - are symmetry debts of light awaiting payment through time. Understanding the nature of the symmetry debt of each charge and how it may be repaid is a major step towards comprehending the Unified Field Theory. (See:

"Symmetry Principles of the Unified Field Theory"; see also: "Currents of Symmetry and Entropy"; see also: "The Tetrahedron Model in the Context of a Complete Conservation Cycle".

The Unified Field Theory can be approached or modeled in many ways. Below I list a "cascade" of conservation requirements beginning with the birth of the Universe in the "Big Bang", and continuing to the eventual repayment of all symmetry and entropy debts by the actions of the four forces (matter-antimatter annihilation, proton decay, and Hawking's "quantum radiance" of black holes). (See: "Table of the Higgs Cascade"; and "The Higgs Boson and the Weak Force IVBs".)

1) "Life-friendly" physical constants (c, G, e, h, etc.) - acquired from the Multiverse as a random sample of infinite possibilities ("Anthropic Principle"). Requirement of zero net energy and charge and complete conservation capability in order to manifest. (Seen as matter-antimatter particle-pairs and free vs bound electromagnetic energy (hv = mcc)). Negative energy is supplied by gravitation; matter's negative gravitational energy is equal to its positive rest-mass energy. When gravity is initially joined with the other forces, positive and negative energy is balanced.

2) Requirement for symmetry-breaking of primordial particle-antiparticle pairs. Seen as fractional charges of quarks (to provide electrically neutral nuclear combinations), and as alternative charge carriers to circumvent antimatter charge partners. (Leptons, "handed" neutrinos; the proton/electron combination, etc.). Seen also as the weak force asymmetry in decays of electrically neutral leptoquark-antileptoquark pairs producing a net residue of matter. Perhaps seen also in the three-family structure of elementary particle masses thought necessary to produce the primordial matter-antimatter asymmetry. (See: "The Origin of Matter and Information".)

3) Requirement to conserve the raw energy, symmetry, and entropy of light in matter (seen as the mass, charge, and time of bound forms of electromagnetic energy). Noether's Theorem. *The charges of matter are the symmetry debts of light*. Symmetry debts may be held in time for future payment (charge conservation); energy and entropy debts must be paid immediately (mass/momentum/time equivalent energy and dimensionality). Gravity is both a symmetry and an entropy debt of light, creating matter's time dimension (immediately) by the annihilation of space (hence conserving light's entropy drive), and conserving light's symmetry (eventually) by the conversion of bound to free energy (in stars, and via many astrophysical processes).

4) Requirement to maintain charge invariance and protect the original value of symmetry debts (through time, despite entropy and relative motion). Seen in Quantum Mechanics as quantized, conserved, invariant charges which allow exact replication and hence conservation (via the principle of charge conservation). Weak force production of single, invariant elementary particles via massive IVBs (Intermediate Vector Bosons), as scaled by the Higgs boson, recreating "Big Bang" force-unity symmetry states. All elementary particles must be identical to others of their kind, including those created eons ago in the "Big Bang". (See: "The Higgs Boson and the Weak Force IVBs".) Elementary particles are always created from particle-antiparticle pairs, which exist as potential forms of bound electromagnetic energy in the "vacuum" or spacetime metric - this is the necessary basis of their universal uniformity in time and space. Whereas the electromagnetic force only creates particle-antiparticle pairs, the weak force creates single particles, which is why it must reproduce the initial environmental conditions of the "Big Bang" via the Higgs boson (mass scalar) and the massive IVBs (transformation mechanism). Other "local gauge symmetry forces" ("holding forces") include: time, magnetism, and "Lorentz Invariance" (energy, charge, and causality conservation for objects in relative motion and in gravitational fields (clocks run slow and meter sticks shrink - protecting causality, velocity c, and the "Interval" - Special and General Relativity). (See: "Local vs Global Gauge Symmetry in the Tetrahedron Model: Part I"; and "Material Effects of Local Gauge Symmetry; Parts 2, 3, 4".)

5) Evolutionary and life forces - information and fractal algorithm; origin of life via universal 4x3 fractal algorithm; purpose of life: the universe becomes self-aware and explores itself, including its creative potential, which expands through life, evolution, and humanity. (See: "Darwin, Newton, and the Origin of Life".) (This is a requirement for our Universe, but perhaps not for others.)

6) Requirement to pay symmetry debts - the four forces are demands for payment of matter's symmetry debts. Matter-antimatter annihilation; fusion/fission/proton decay; Hawking's "quantum radiance" of black holes. The Sun is a local, partial example of this spontaneous process. Gravity creates time from space and vice versa (in stars, during the conversion of mass to light); gravity is a symmetry and an entropy debt of light's non-local symmetric energy state. The intrinsic motion of light (light's entropy drive) and the "non-local" distributional symmetry of light's energy are both gauged (regulated) by velocity "c". Light has no spacetime location; light's "Interval" = zero. Gravity's "location" charge (of which time is the active principle) conserves both light's entropy drive and light's non-local distributional symmetry: light's entropy drive is conserved immediately (as time), and light's non-local distributional symmetry is conserved (eventually) through the conversion of mass to light in stars and via Hawking's "quantum radiance" of black holes. (See: "The Double Conservation Role of Gravity".) The dimensions of spacetime are conservation domains for free and bound electromagnetic energy, produced by the intrinsic (entropic) motions of light, time, and gravity. Time is gravity's gift to the Cosmos. *Gravity is matter's memory it once was light.*

Symmetry Debts of the Four Forces (and repayment modes)

Light creates matter which bears charges. *The charges of matter are the symmetry debts of light*. Charges produce forces which are demands for payment of the symmetry debt.
(See: "Table of the Four Forces" (short form)) (See: "Table of the Four Forces" (long form))

1) Electromagnetic Force: Electric charge. Photons. 2-D vs 4-D: 2-D (and 3-D) symmetric dimensionality of light vs 4-D asymmetric dimensionality (time) of matter. (Light is a two-dimensional transverse wave whose intrinsic motion sweeps out a 3rd spatial dimension. However, as Einstein discovered, light has no time dimension.) Repayment via exothermic chemical reactions (partially) and matter-antimatter annihilations (completely). (Suppression of time dimension, and suppression of the spontaneous manifestation of mass-matter via annihilation of "virtual" particle-antiparticle pairs.) "Velocity c" is the universal gauge of electromagnetic energy regulating the spatial metric (including the metric's inertial symmetry and the absence of a time dimension when matter and gravity are also absent). "Velocity c" gauges the entropy drive of light, the non-local distributional symmetry of light's energy, the "Interval", causality, the equivalence of free and bound electromagnetic energy, the value of electric charge, etc. Hence to think of "c" as merely the regulator of an "absolute" velocity is to seriously underestimate the universal conservation role of "c" in Nature. (See: Symmetry Principles of the Unified Field Theory" (Part 1) (Part 2).

2) Strong Force: Color Charge; Gluons. Fractional vs whole quantum charge units. Quark fractional charges vs leptonic (elementary) whole unit charges. Permanent quark confinement (to whole charge units) via the gluon field. Repayment via the nucleosynthetic pathway in stars (fusion), and via proton decay. (Suppression of free-roaming fractional charges which could not be annihilated or otherwise balanced by the whole charge units of leptonic alternative charge carriers.) (See: "The Strong Force: Two Expressions".)

3) Weak Force: "Identity" Charge (AKA "flavor" or "number" charge). Distinguishable identity of elementary massive leptonic particles (including leptoquarks) vs anonymity of massless identical photons. (Neutrinos are "bare" identity charges.) Repayment via radioactivity (fission), particle and proton decay, and via contributions to the nucleosynthetic pathway of stars. Initial creation of matter in the "Big Bang" via an unknown weak force asymmetry; subsequent creation of (single) invariant elementary particles via weak force IVBs and the Higgs boson. Weak "identity" charge indicates appropriate antimatter partners for swift annihilation reactions (left vs right-handed neutrinos and "flavor" charges). (Selection of conservable and uniform elementary particles from the vacuum "sea" of possibilities (suppression of all others); distinguishes

matter vs antimatter via neutrino "handedness".)

4) Gravitational Force: "Location" Charge. Non-local ("global") distributional symmetry of photon's energy (due to intrinsic spatial motion c) vs asymmetric ("local") concentration of mass energy in particles (which lack any intrinsic spatial motion). Due to the lack of a time dimension and a spatial dimension (in the direction of propagation), the photon has forever to go nowhere. Furthermore, due to the lack of two dimensions, the photon's location in either 3 or 4 dimensions cannot be specified. The photon's energy (in its own reference frame) is therefore distributed symmetrically everywhere simultaneously in space. Massive particles break this symmetry because they lack (net) intrinsic spatial motion of any kind and their location in space and spacetime can therefore be specified - breaking the distributional symmetry of the photon's energy and giving rise to the gravitational "location" charge carried by every massive particle and bound energy form (Gm) - but not by light or by any non-local particle traveling at "velocity c". (See: "Dark Energy: Does Light Produce a Gravitational Field?"). The active principle of the gravitational charge is time. (See: "A Description of Gravitation".) Repayment via the gravitational conversion of mass to light as in the stars, supernovas, and quasars (partially), and via Hawking's "quantum radiance" of black holes (completely). (Suppression of "wormholes", causality violations, and connections to other universes - via the "event horizon" and the central "singularity" of black holes.) (Gravity connects the primordial entropic drives of free and bound electromagnetic energy ("intrinsic" motion c and "intrinsic" motion T), and furthermore provides their dimensional and inertial connection via its influence upon the electromagnetic metric - gravitational "Lorentz Invariance".)

The four forces can be related (in a general sense and with some overlap) to the four conservation principles of the "Tetrahedron Model" as follows:
1) Energy Conservation - light, free electromagnetic energy: Electromagnetic Force;
2) Entropy - c, G, T (intrinsic motions of light, gravity, time - space, spacetime, history): Gravitational Force;
3) Symmetry Conservation - charge, charge conservation, and symmetry-breaking: Weak Force;
4) Causality-Information - nuclear matter, mass, bound electromagnetic energy: Strong Force.

The four forces help the electromagnetic energy system manifest through the Higgs Cascade via "unified-force symmetric energy states" which provide stages, stepping stones, or energy plateaus (symmetry domains) in which precisely replicable transformations (from greater to lesser unified-force symmetry states) can occur, allowing the next lower symmetric force domain to manifest in a reproducible, quantized, and conservable form. The "cascade" devolves in four stages:

> 1) TOE (Theory of Everything) - all forces unified, fermions and bosons unified;
> 2) GUT (Grand Unified Theory) - strong and electroweak forces unified, quarks and leptons unified;
> 3) EW (Electroweak Unification) - quark families unified and lepton families unified (each separately);
> 4) EM (Electromagnetic Unification) - "ground state", electric and magnetic forces unified. (See: "Table of the Higgs Cascade".

Once the ground state is reached, the same four forces begin the slow but sure process of symmetry debt payment, as outlined above. While this restoration of symmetry is going on, there is plenty of time and energy available for the evolution of life and the self-awareness and self-exploration of the cosmos, including new creative modes (as in human creativity). The same information (charge) that conserves and restores symmetry is used to create life, following the 4x3 fractal information pathway. Human spirituality (including ethics) and creativity (including aesthetics) are our most highly evolved capacities; human appetites and destructiveness our least. (See: "The Fractal Organization of Nature".)

Finally, we ask why the universe bothers to exist at all? Speaking teleologically, it's just that existence is so

much more interesting than non-existence. The "Trinity" gets bored of its own perfection; it needs a "project" to work on and busy itself. And with so much creative energy in play, spontaneous symmetry-breaking from the Multiverse is bound to occur ("eternal inflation"?). We are the means whereby the Universe explores and evolves its creative potential, and experiences, ponders, and looks at itself; it is therefore no wonder that we often find an image of ourselves looking back. (See: "The Human Connection".)

Links:

Introduction to the Papers

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Section IX: Symmetry: Noether`s Theorem and Einstein's "Interval"
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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
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