Section 9 - Symmetry: Noether`s Theorem and Einstein's "Interval"
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The Charges of Matter are the Symmetry Debts of Light

Papers:
Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part I
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Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 3 (Summary)

See also:
NY Times article on Emmy Noether 26 Mar 2012

Discovering "Noether's Theorem" and the principle of symmetry conservation was one of the two keys that opened my personal door to the unification theory. The second key was Einstein's statement that the spacetime "Interval" of light was equal to zero.

Noether's theorem states that in a multicomponent field, such as the electromagnetic field (or the metric field of spacetime), where one finds a symmetry one also finds an associated conservation law, and vice versa. I soon came to realize that because matter is created from light, this theorem means that any symmetry of light must somehow be conserved in matter, and that (one of) the real world consequences of Noether's Theorem was *the charges of matter are the symmetry debts of light*. Charge conservation (including "spin") = symmetry conservation, in the case of the electromagnetic field; in the case of the metric field of spacetime, the physical consequence of Noether's theorem is the presence of inertial forces and gravitation. The conservation of "spin" (the quantized spin angular momentum of particles) seems to be a mixture of the charge and inertial force cases. Because the theorem works in two directions, any charge of matter must be associated with a symmetry of light; and further, because charges produce forces, gravity also must be the product of some charge of matter, and therefore gravity presumably represents some symmetry debt of light. In accordance with Noether's Theorem, charges produce forces which act to return the asymmetric material system to its symmetric origin in light. In the case of gravity, we have the example of our Sun, the stars, quasars, and Hawking's "quantum radiance" of black holes, returning bound energy to its original symmetric state, light.

But what broken symmetry of light does gravity represent? What is the nature of the gravitational "charge"? For each of the four forces of physics, there must be an associated charge, and these charges are all (presumably) symmetry debts of light. When light is converted to matter, it loses a lot of symmetry - in fact, according to this line of thought, symmetries of at least 4 different kinds, each of which requires a different kind of conserved charge. The action of the force produced by the charge is therefore understood as the attempt to pay the conserved symmetry debt carried (represented) by the charge, returning the system to its original symmetric state (light), in obedience to Noether's Theorem. The electric charge is prototypical of this effect:

> When light creates particle-antiparticle pairs, the particles are produced with opposite and strictly conserved electric charges, whose whole purpose is to produce a long-range

> attractive force between the particles with sufficient strength to produce an annihilation reaction within the Heisenberg time limit for "virtual reality", returning the particle pairs to the symmetric state of free energy which created them. Because the photon is the field vector (force carrier) of electric charge, we see light protecting its own symmetry in such annihilations, which occur continuously in the "virtual particle sea", the Heisenberg realm of virtual reality.

A pathway to the conceptual unification of forces therefore presents itself: identify the symmetries of light which the charges and forces of matter represent; all charges, forces, and particles have their origin in light, which becomes the principle of unification. The question becomes: what are the 4 symmetries of light represented by the 4 charges and forces of physics? This question is pursued (and answered) in the various unification papers, especially: "Symmetry Principles of the Unified Field Theory".

I like to think of Noether's theorem (1918) as the "Truth and Beauty" theorem, as it appears to be nothing less than the mathematical expression of Keat's famous poetic intuition: "Beauty is truth, truth beauty, - that is all ye know on Earth, and all ye need to know" (1819) - where conservation plays the role of truth, and beauty = symmetry. This is an outstanding example of the correspondence between the rational and intuitive powers and sensitivities of the human mind: neither one is to be slighted, much less dismissed.

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. In the mathematical terms of Evariste Galois' "Group Theory", the "Tetrahedron Model" is a description of the symmetry group of light, including its destruction by asymmetric weak force decays (producing our matter-only Cosmos), and its on-going restoration in obedience to Noether's Theorem of symmetry conservation (as in the conversion of bound to free energy in stars).

(See: *Emmy Noether: A Tribute to her Life and Work*. Brewer, J. W. and M. K. Smith, eds. M. Dekker, New York, **1981**. See also: Neuenschwander, Dwight E. *Emmy Noether's Wonderful Theorem*. 2011. The Johns Hopkins University Press.)

Einstein's "Interval"

The "Interval" of Light = Zero

The second key in my understanding of the unification pathway was Einstein's mathematical statement that the spacetime "Interval" of light = zero. Einstein's "Interval" is an invariant measure of the "quantity" or "interval" of spacetime separating two events. The Interval is so mathematically formulated that it is invariant with regard to the relative motion of observers, and its chief role is to rescue causality from Einstein's shifting relativistic perspectives of space and time in moving frames of reference. Thus moving observers of two events will not agree, in general, on the space and time measurements separating those events, but they will always agree upon the mathematical product of those measurements when combined in Einstein's formulation of the "Interval". The invariance of causality depends upon the invariance of the Interval and the absolute (non-relative) velocity of light.

The zero "interval" of light means light is "non-local", having no time dimension and no spatial "x" dimension corresponding to length or distance - light's "clock is stopped" and meter sticks shrink to nothing in the direction of light's propagation. Light is a 2-dimensional transverse wave. Velocity c, the intrinsic motion of light, is a symmetry condition, drive, or "gauge" for light (free energy) which results in light's "non-local" character. The zero Interval of light is the formal (mathematical) expression of this fundamental symmetry of light, its "non-local" energy state. Several related symmetries flow from light's "non-locality": 1) light has no asymmetric time dimension; 2) light has no asymmetric (local) "rest" mass; 3) light produces no asymmetric gravitational field; 4) being non-local, with an infinite amount of time to go nowhere, in its own reference frame, moving at velocity c, light is everywhere within its conservation domain (spacetime) simultaneously.

The effectively "infinite" velocity of light results in another symmetry - the equitable distribution of light's energy throughout its conservation domain, everywhere, simultaneously - a symmetry of special significance for gravitation and matter's "location" charge. "Non-locality" also allows light, or velocity c, to act as the metric gauge of spacetime, including its inertial symmetry, regardless of the size or motion (expansion, contraction) of the domain. Non-locality has the further consequence of producing a condition of complete unity and connectivity between light and space throughout light's conservation domain of spacetime. It is the (broken) non-local distributional symmetry of light's energy which is the source of the gravitational "location" charge in matter. "Location", a charge whose active principle is time, identifies the spacetime location, quantity, and density of bound energy. Matter is an immobile and hence undistributed lump of concentrated mass or bound electromagnetic energy (E = mcc).

The connection between symmetry and entropy enters our theory with "velocity c", which is the symmetry gauge of free energy, banishing time, distance, mass, charge, and gravitation. "Velocity c" also gauges the entropy drive of free energy (the intrinsic motion of light), causing the expansion and cooling of light's spatial conservation domain - the Cosmos. This double gauge role of "velocity c" is reflected in the corresponding double conservation role of gravitation: gravitation produces the time dimension of matter, identifying the 4-D spacetime location of mass (light's distributional symmetry debt); the intrinsic motion of time also serves as the historical entropy drive of matter (light's "intrinsic motion" entropy debt). Hence gravity: 1) produces the time dimension of matter via the annihilation of space, conserving the spatial entropy drive of light's intrinsic motion as the historical entropy drive of time's intrinsic motion; and 2) converts bound to free energy (as in stars, quasars, and Hawking's "quantum radiance" of black holes) to conserve the distributional symmetry of light's non-local energy state. Because both light's entropy drive and non-local distributional symmetry are gauged by "velocity c", to conserve either function is to conserve the other by default. This has the significant consequence that gravity's entropy conservation role also falls under the symmetry conservation mantle of Noether's Theorem. Time is a charge with a symmetry conservation role - as demonstrated by gravity's conversion of bound to free energy in the stars. (See: "The Double Conservation Role of Gravity"; see also: "The Conversion of Space to Time".)

The "location" charge of gravitation carries both the entropy debt and the symmetry debt of light's non-local energy state; it is this double role that has made gravity such a difficult force to understand. The active principle of the gravitational charge is time; the one-way spacetime flow of gravitation is the consequence of time's intrinsic one-way motion into the historic domain of spacetime. It is the causal function of time that requires its one-way flow. See: Entropy, Gravitation, and Thermodynamics"; also "A Description of Gravitation".

Symmetry and entropy are connected in light because light occupies its conservation domain completely (space is actually created by the intrinsic motion of light), and the most symmetric dispersion of light within its domain also has the greatest entropy. However, entropy has a further component, temperature, such that while hot or cold light has the same symmetry, cold light has the greater entropy. Hence entropy rather than symmetry actually drives the expansion of space. None of these considerations apply to bound energy (matter), which does not occupy its conservation domain completely (historic spacetime), and does not participate in the expansion of either spacetime or history. It is because of these differing dimensional characteristics that the entropy drives of free and bound energy (the intrinsic motions of light and time as gauged by "velocity c" and "velocity T") are so vastly different in their entropic consequences and metric equivalence, a difference which we perceive as the anomalous weakness of gravitation. Bound electromagnetic energy (matter) is only tangentially connected to its historical conservation domain via the ephemeral "present moment". Gravity produces only enough time to provide the temporal entropy drive for this tangential point of contact between matter and history (actually seen as the area of the "event horizon" of a black hole). (See: "Proton Decay and the 'Heat' Death of the Cosmos".

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Noether's Theorem

Noether's theorem applies generally only to continuous parameters, such as space and time, and only in particular cases to discontinuous parameters, such as charge. Nevertheless, since charge conservation is well established both observationally and experimentally, it is very likely that the theorem applies also in the particular case of charge. If nothing else, this is the hypothesis to be advanced, and we make the case with numerous arguments throughout this and other papers on the website. (See: Neuenschwander, Dwight E. *Emmy Noether's Wonderful Theorem*. 2011. The Johns Hopkins University Press pp. 192 - 199.)

In the terms of Evariste Galois' mathematical "Group Theory", the "Tetrahedron Model" is a qualitative description of *the symmetry group of light*, or free electromagnetic energy.

Overview

Regarding the question of continuous symmetries in the "Tetrahedron Model":

1) From unknown origins (?inflation via the Multiverse?), the Universe begins in a state of perfect symmetry with equal parts of matter and antimatter (the "Big Bang" or "Creation Event"). Matter-antimatter symmetry is the primordial energetic state of the Cosmos; due to continual and instantaneous annihilation reactions, this primordial symmetric state is equivalent to pure high energy light (electromagnetic radiation). Total energy and charge is zero since the contribution of both from antimatter is negative. This primordial electromagnetic symmetry must somehow be broken to produce our asymmetric Cosmos of bound and free electromagnetic energy (matter plus light).

2) Maintaining the primordial symmetry of light is the role of electric charge, as the opposite electric charges of matter vs antimatter attract each other and motivate annihilation reactions. Light is a perfectly symmetric energy form, carrying no charges, having no time dimension, and having no

"location" in space (since in its own reference frame light is everywhere simultaneously). Light is a "non-local" 2-dimensional transverse wave having no spatial dimension in the direction of propagation nor any temporal dimension. Light has no mass, produces no gravitational field, and travels with an "intrinsic motion c" which creates an expanding and cooling domain - the entropic spatial conservation arena of free electromagnetic radiation. This is the primordial symmetric energy state of light which electric charge protects and conserves via matter-antimatter annihilation reactions. Light exhibits a continuous "non-local" symmetry - like space itself, it is globally symmetric everywhere, and any photon (or wave of electromagnetic radiation) can be swapped for any other. "Velocity c" is best conceived not as an actual velocity, but as the gauge of the non-local symmetric energetic state of free electromagnetic energy, including the metric symmetry of space (created by light's intrinsic, entropic motion) in which time, gravitation, and mass are banished ("mass" is a bound form of electromagnetic energy with no intrinsic spatial motion; instead, mass has intrinsic temporal motion, producing a "gravitational field"). Light's "velocity" in its own reference frame is essentially infinite, as it has forever to go nowhere (time stops and meter sticks shrink to zero at "velocity c"). Light protects its own symmetric energy state via matter-antimatter annihilations motivated by electric charge (the photon is the field vector of electric charge). Electric charge is "discrete" but the symmetry it protects is continuous; we know in any case that electric charge is absolutely conserved.

3) Breaking the primordial electromagnetic symmetric energy state is the combined role of the strong and weak nuclear forces, which early-on work in concert to produce our "matter only" cosmos.

4) Restoring the symmetric energy state of light is the patient and inexorable role of gravity. Light's symmetric energy state is broken (due to the asymmetric activity of the two nuclear forces) by the creation (from light) of massive, local, temporal, and immobile matter. Gravity converts mass back to light in stars, quasars, and, via Hawking's "quantum radiance", in black holes. Gravity and its "location" charge are continuous to the extent spacetime is continuous. We also know the gravitational "location" charge is conserved, as no massive particle has ever been found without one; nor can a gravitational charge be destroyed except by total conversion of mass to light, which completely repays the gravitational symmetry debt or "location" charge. The gravitational "location" charge (Gm) is conserved to the same extent that mass (m) is conserved.

Because the gravitational metric of the black hole causes all things, regardless of mass, to move at velocity c, it is apparently just as symmetric as the original electromagnetic metric of light, which it replaces. "The extremes meet": perhaps this is why gravity drives so relentlessly toward the formation of black holes - they represent the ultimate symmetric energy state of matter. In any case, we expect black holes to be full of nothing but light, due to proton decay in the interior, perhaps in the extreme pressure of the central "singularity". However, the entropy drive of black holes, being contractile one-way time/gravity, is less symmetric than the entropy drive of space/light, which is expansive "all-way". Hence in accord with Noether's Theorem, black holes should eventually convert their one-way entropy drives to light's all-way entropy drive, and evaporate (Hawking's "quantum radiance").

(See: "A Description of Gravity"; see also: "The Conversion of Space to Time"; see also: "Nodes of the Gravitational Metric".)

Symmetry Breaking

3a) Breaking the primordial symmetry of light via the combined asymmetric action of the nuclear forces: the strong and weak forces act together. (See: "The Particle Table".)

In the bound energy (atomic matter) section of the "Tetrahedron Model", we enter a more "discrete" area of physical theory, involving the "identity" and "color" charges of the weak and strong forces. Both these charges, however, conserve and protect continuous symmetries that eventually refer back to spacetime and light, and the primordial electromagnetic symmetry between matter and antimatter. When considering "discrete" particles or properties of matter, we should remember Heisenberg's Uncertainty Principle, deBroglie's wave/particle relation, and Born's probabilistic interpretation of Schrodinger's collapsed wave function - all of which suggest links between so-called "discrete" particles and the continuous realm of waves, spacetime, and light.

Symmetry-breaking begins when a primordial super-massive lepton - a "leptoquark", the heaviest member of the leptonic spectrum of elementary particles, breaks into three parts (quarks) under the self-repulsion of its own electric charge, seeking a lower energy distribution of its mass and electric charge. This self-disintegration places a natural upper limit on the mass of the elementary particle (leptonic) spectrum. Such a disintegration is possible and permitted (lawful) only because the strong (color) force is available to hold the fractured particle together into a quark combination featuring a whole leptonic unit of electric charge (the reassembled original charge) - such as a proton, or else no charge at all (the quark combination of a neutron), provided in the latter case the original electric charge can be transferred to and conserved by some other member of the leptonic spectrum (such as an electron).

The strong force "gluon" field springs naturally from the splitting of the massive body of the leptoquark - gluons seem to be versions of split photons (photons are the field vectors of electric charge), apparently determined to hold the original charge together as a whole quantum unit, at least as seen by the outside world. (See: "The Strong Force: Two Expressions".) Gluons attract each other and have been compared to "sticky light", and exhibit "asymptotic freedom", attracting each other more strongly as the quarks attempt to separate, less strongly as they crowd together. (See: Science 15 Oct. 2004 Vol. 306 p. 400) It all makes sense from the perspective of symmetry conservation, as these whole unit charges are necessary for cancelling, neutralizing, or carrying the charges of other members of the leptonic elementary particle spectrum, or annihilating the opposite charges of antimatter. The strong force protects the global and continuous symmetry of whole quantum units of (electric) charge. Throughout the spectrum of electrically charged leptons and hadrons, every charge is the equivalent of every other charge, able to replace, neutralize, or even annihilate its opposite number as the opportunity arises. Charge conservation is symmetry conservation by proxy. *The charges of matter are the symmetry debts of light*.

Because of the three-family structure of the quark spectrum, many (15) electrically neutral quark combinations are possible - heavy analogs of the neutron. These electrically neutral leptoquarks are subject to leptonic weak force decays in which a leptoquark neutrino (conserving "lepton number charge") and a neutral pion (conserving energy) replace the leptoquark (as mediated by the heavy "X" IVB). (See: "The Origin of Matter and Information".) During the early micro-moments of the "Big Bang", an asymmetry of unknown origin produced slightly more of these weak-force decays in the anti-leptoquark population (about one extra per billion decays), leaving our universe with an excess of matter leptoquarks - which subsequently decay to protons and neutrons. This may provide an "anthropic" explanation for the otherwise mysterious existence of the three quark-lepton families - they are necessary to create sufficient numbers of neutral leptoquarks for the weak-force asymmetric decays that produced our "matter only" cosmos.

The role of the strong force is to maintain the uniformity (symmetry) of quantized whole charge units throughout the spectrum of elementary particles - whether they be elementary leptons or composite hadrons comprising quark triplets or doublets (the strong force requires the electric charges of baryons and mesons to conform to those of the pre-existing elementary leptonic spectrum - from which the leptoquarks are derived). By means of this symmetry, all electrically charged fermions (baryons, mesons, leptons) can carry, cancel, or neutralize each others' electrical charges, and annihilate the electric charges of their corresponding antiparticles.

The strong force facilitates the breaking of the primordial electromagnetic symmetry between matter and antimatter by enabling the creation of nuclear sub-units (quarks) and hence the formation of electrically neutral leptoquarks. Symmetry-breaking occurs via the asymmetric weak-force decay of electrically neutral composite quark combinations (electrically neutral leptoquarks) - decaying to the matter-only barons of our cosmos (protons, neutrons, hyperons).

The "gluon" field of the strong force also exhibits a symmetry between its "color" charges that allows any quark to bond with any other quark, providing the electrical charges of the quark combination sum to whole quantum (leptonic) charges (including zero). Color charges themselves must sum to "white" (red/green/blue combinations, as in baryons) or neutralize each other (color/anticolor combinations, as in mesons). The symmetry of the gluon color field is continuous in the sense that all color charges are equivalent (and hence can be swapped among themselves), just as all electrical charges are equivalent and can be traded or shared between particles as a common currency (as in the universal proton-electron atomic combination). Like electric charge, color charge is strictly conserved - as we should expect, if the latter is actually a subdivision of the former. Because gluons are composed of color-anticolor charges in every combination, the gluon field as a whole must sum to zero. This final symmetry of the color force leads to the expectation of proton decay at very high energy (perhaps via the massive "X" IVB, and/or at the central singularity of black holes).

The Weak Force: (See: "The "W" IVBs and the Weak Force Mechanism".)

Whereas the strong force controls the global (universal) symmetry of electric charge among the leptons and hadrons (protecting whole quantum unit charges), the weak force controls the global or universal symmetry of mass between all particles of a given species. Electrons, for example, are created with exactly the same mass wherever and whenever they are "born"; an electron created in the decay of a neutron today could be swapped with an electron created aeons ago during the "Big Bang", and nobody would know the difference. This global or universal symmetry of mass (rest-mass energy) within any elementary particle species, lepton or quark, is due to the activity of the weak force and the mediation of its "Intermediate Vector Bosons" (IVBs). Not only does this symmetry allow one member of a particular species to be seamlessly swapped for another of its kind, it allows the annihilation reactions of particle-antiparticle pairs to proceed in a timely and orderly fashion -

conserving light's symmetry (always the " bottom line").

The weak force is the only force capable of creating, destroying, and transforming *single* elementary particles (quarks and leptons) - as opposed to particle-antiparticle pairs. How does it manage to create them all with perfectly identical masses (within type)? The heavy masses of the weak force IVBs (~80 and ~90 proton masses respectively for the "W" and "Z" IVBs) simply recreate the primordial energetic conditions under which these particles were originally created. Within type, they are all stamped out of the original mold, as it were. In turn, the Higgs boson gauges (determines) the masses of the IVBs, selecting the force-unification era of the early universe in which these particles were first created (the electroweak force-unity era, in the case of our ordinary particles). (See: "The Higgs Boson and the Weak Force IVBs".)

Of the charges of the four forces, the "identity" charge of the weak force may be the most interesting. Neutrinos are the explicit form of this charge, one for each of the three known elementary leptons, the electron, muon, and tau (and another set for their antiparticles). I presume there exists a 4th neutrino, the identity charge of the leptoquark. If it does exist, it may be quite heavy and be the source of the mysterious "dark matter". The neutrinos are mysterious particles, and much remains to learn about them. (See: Scientific American May 2010 p. 38 "Through Neutrino Eyes" Gelmini et. al.)

The "identity" charge is the symmetry debt of the photon's state of "anonymity": every photon is identical to every other photon (hence "anonymous"), but the massive elementary leptons are distinctly different from the photon and from one another - the muon is about 200 times heavier than the electron, and the tau is about 3600 times heavier (the photon is massless). While neutrinos carry leptonic "identity" charge in explicit form, the massive leptons themselves carry it in "hidden" form, where it is recorded simply as "lepton number" charge. The "hidden" form is necessary because the identity charge of the neutrinos involves "parity" (left- or right-handed spin), and massive particles cannot conserve this charge. Ordinary neutrinos are almost massless and travel at very nearly velocity "c", so they do an almost perfect job of conserving this charge. All neutrinos are left-handed, and all anti-neutrinos are right-handed, neatly distinguishing matter from antimatter, and leading to the notion that our universe is in some sense "left-handed". The weak force reactions of matter are therefore said to be left-handed, while those of antimatter are right-handed - in terms of spin or "parity". Parity is conserved when the universe and anti-universe are considered jointly.

In all the Universe there are only three (perhaps 4) species of elementary particles - the leptonic spectrum. Only elementary particles have associated neutrino "identity" charges - quarks have none as they are sub-elementary. (I presume the leptoquark neutrino carries the identity charge for the quarks and baryons). The neutrino is in effect a "certificate of authenticity" that guarantees "this is the genuine article" - an elementary particle that is correct in all its conserved parameters - charge, spin, mass, etc. - and hence can be "swapped out" for any other of its kind ever made, and (of special importance) can annihilate with its antiparticle, thereby returning both to the original symmetric energy state of light from which they were created.

To create a new (single) electron however, is a monumental task, as it must be the same as any other electron ever made (or that ever will be made). This requires the mediation of the very massive "W" IVB (Intermediate Vector Boson: ~80 proton masses), to re-create the original energy density of the early micro-moments of the "Big Bang" in which electrons were first created. This is in fact the energy density of the *electroweak force-unity era,* the time and energy at which the electromagnetic and weak forces were unified. The characteristic of this unification energy is that the massive leptons and their neutrinos are all equivalent, swapping specific identities amongst themselves as if they were all members of a single genus (the "leptonic genus"), rather than distinct species or particles. Similarly, the quarks are likewise swapping specific identities ("flavors") amongst themselves as if they were all equal members of a single "hadron genus" (there are no neutrinos for the quarks; quarks are present as quark-antiquark pairs of all "flavors"). At the electroweak force-unity energy level, transformations of lepton/lepton or quark/quark identity or flavor are effortlessly accomplished. However, quarks and leptons do not mix at the electroweak energy level. (See: "The Higgs Boson and the Weak Force IVBs".)

The leptonic spectrum of elementary particles is clearly some sort of resonant series. In this case it appears to be a resonant series of the combined electromagnetic and weak forces. The leptonic series identifies the mass-energy at which the electromagnetic/photon and weak force/neutrino frequencies are in sympathetic vibration - the leptonic particle series delineates the nodes of sympathetic vibration or resonance between these two forces at the electroweak energy level. The electromagnetic force can probably produce particles of any rest-mass energy, but it is only at the nodes of the resonance series where these two forces are in sympathetic vibration that massive particles can be paired with neutrino identity charges. This joining of forces is necessary to produce particles that can be conserved in the sense that they can be exactly reproduced at any time and place, matching up exactly with others of their kind, including in annihilation reactions with their antiparticles.

We see the massive IVBs as energetic "keys" which open the door to a conservation domain of massive particles - the leptonic spectrum. These keys are quantized pulses of energy which pluck the strings of the cosmic lyre of spacetime with exactly the right energy to establish a sympathetic resonance between the electromagnetic and weak forces, producing massive particles of bound electromagnetic energy which are conserved by weak force identity charges -symmetry debts of light's "anonymity".

The "identity" charge of the weak force is the most significant of the charges of the four forces. It is the beginning of Information, and from this humble beginning proceeds the entire manifest universe.

While the huge masses of the IVBs "steal the show" in the weak force, what is important is the uniformity of the leptons produced in the process, and this depends upon the neutrino identity charges. It is somewhat similar to the massive human body which must be used to create the next generation via a minute quantity of genetic material; the body is impressive but it is the microscopic genes which count. Imagine what would happen if no identity charge were required for the creation of (single) leptons - electrons of every conceivable mass could be produced with untold consequences for the formation of atoms and for annihilation reactions with antiparticles.

Elementary particles are special forms of bound energy and the Universe is prepared to produce and conserve only a very few types. The major requirement is that they must (as leptons) be able to pair with a neutrino identity charge, which ensures they can be absolutely conserved and accurately reproduced. As for the quarks, they are held to the "neutrino standard" only at the higher energy of the leptoquark (the GUT or "Grand Unified Theory" force-unity energy level), but not at the lower energy of the electroweak force. However, they appear only as quark-antiquark pairs (mesons) in the electroweak "fluid", so their match-up with antiparticles is in any case never an issue.

Hence we have the long-range pair of "spacetime" forces - the electromagnetic and gravitational forces - responsible for creating and conserving the continuous symmetries of space and time; and we have the short-range pair of "particle" forces - the strong and weak forces, responsible for creating and conserving the continuous symmetries of whole quantum units of electric charge, and the invariant "rest" mass (within type) of elementary particles. All four forces work together to produce the charged and massive particles, planets, stars, and galaxies of our Universe. Noether's Theorem unites them all: *The charges of matter are the symmetry debts of light*.

Conservation Laws and "Intrinsic" Drives

We have mentioned the foundation stones of our universe, the four forces and their charges, deeply buried in time and beneath multiple layers of conservation laws, intrinsic drives, broken symmetry, and evolutionary phenomena which mask and modify their appearance.

Of the conservation laws, the conservation of energy is the most important, followed by the closely related conservation of symmetry (as set forth in "Noether's Theorem"). Not only the quantity of energy, but also its quality must be conserved.

Of the intrinsic drives, entropy, evolution, and matter's search for antimatter are the most important. The entropy drives include the intrinsic motion of light, the intrinsic motion of time, and gravity (negative entropy). Entropy is a corollary of energy conservation, allowing the use of energy but preventing its abuse (the same energy cannot be used twice to produce the same work). The intrinsic motion of light produces space and its expansion and cooling; the intrinsic motion of time produces history and its expansion and decay; gravity converts space into time and vice-versa, producing historic spacetime - the combined entropic conservation domain of free and bound electromagnetic energy (light and matter). (See: "Temporal vs Spatial Entropy".) Time and history are alternative entropic drives/domains for matter, since massive forms of energy cannot move at velocity c, and hence cannot participate in light's spatial expansion or entropic domain (which is why "diamonds are forever"). The gravitational annihilation of space leaves a temporal residue, the metric equivalent of the annihilated space, while the gravitational conversion of mass to light (as in stars) destroys time and gravitation, creating space.

The inexorable drive of gravity to convert mass to light, restoring the primordial symmetric energy state of light, proceeds via the nucleosynthetic pathway in stars (and supernovae), the direct conversion of gravitational energy to light in quasars, and the total conversion of mass to light via Hawking's "quantum radiance" in black holes. In black holes, the gravitational metric of time finally dominates the electromagnetic metric of space and most of the functions of electromagnetic energy. (Electric charge seems to be strictly conserved regardless of the strength of the gravitational metric.)

Matter's eternal search for antimatter produces the universal electron-proton combination and the electron shells of atoms. The gravity-driven nucleosynthetic pathway (including supernovae) creates all the heavy elements of the periodic table. The information content of matter, embodied in the periodic table of the elements, embarks on an evolutionary journey of incredible length and complexity, culminating in intelligent life forms such as ourselves who can complete the fractal iteration of nature, taking the evolutionary reins in their own hands and moving up to a new, abstract or intellectual level on the evolutionary ladder. Apparently the universe wants to experience and know itself - why not? The conversion of energy to information via symmetry debts (charges) is the key to the mystery of the living, self-aware Cosmos: life arising from the atoms.

The greatest change in the development of the Universe comes with primordial symmetry-breaking and the change from 2-dimensional, massless, non-local and acausal light moving with intrinsic (entropic) motion "c" in space, to 4-dimensional, massive, local and causal matter moving with intrinsic (entropic) motion in time. Laws of absolute motion become laws of relative motion; the symmetric spatial electromagnetic metric of light, gauged by "c", changes to an asymmetric temporal gravitational metric of matter gauged by "G". Historic spacetime serves as matter's causal information repository and "karmic" conservation domain. Gradually, gravity overwhelms the electromagnetic metric and all its functions through the relentless formation of black holes (converting a great deal of mass to light in the process), but even black holes eventually evaporate via Hawking's "quantum radiance", completely converting mass to light and so finally fulfilling Noether's Theorem of symmetry conservation. The gradual reduction of the Cosmos' gravitational energy by the inexorable conversion of mass to light is the mysterious "dark energy" causing the recently observed "acceleration" of the Universe. This is also the evidence that light, moving freely in space at velocity c, produces no gravitational field.

The field vectors of the four forces must not only act to conserve their particular symmetry debts (charges) via annihilation, they must also somehow maintain the value and integrity of these charges in the local realm of relative motion, matter, time, and variable gravitational fields, no less than in the global realm of absolute motion, light, and symmetric space. Symmetry debts must be paid in full and at their original value. The magnetic field of a moving electric charge, the covariance of time and space with moving reference frames, the confinement of quarks by gluon fields of "sticky light", and the huge masses of the weak force IVBs are all examples of these complex compensatory phenomena among the four forces. Mediating between the global vs local, the ideal vs real, the invariant realm of charge vs the relative realm of atomic matter - this is the commonplace, daily task of the field vectors of the four forces. (See: "Global and Local Gauge Symmetry in the 'Tetrahedron Model'".)

Summary

Our Universe exhibits both conservation and flexibility, giving it stability but allowing it to function smoothly within a mixed spacetime domain of absolute charge and relative motion, variable gravitational fields and unpredictable accelerations, light and matter. The information content of the periodic table is transferred via molecular chemistry to DNA and the genetic code of biology. We find again in the genetic mechanism of living organisms a system that combines conservation with flexibility, allowing both evolution and long-lived, well defined species. The Universe comes alive to experience and know itself, and even to improve itself through new modes of creation and new forms of beauty, including the abstract realm of human thought.

The "Tetrahedron Model" is a vast oversimplification of the actual physical system of the Cosmos, but that is its purpose. It intends to reveal the "bare bones", the structural elements, without the flesh, internal organs, and complex biochemistry that animates the creature - the actual living, physical, functioning Cosmos. We are only trying to understand its fundamental laws, forces, and fractal evolutionary structure. To do more is to ask too much of such a simple model. Nevertheless, even if we have only the skeleton of a dinosaur, we find that we have quite a lot.

Links**:**

General Topics:

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