Synopsis of the Unification Theory: The System of Matter

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(see home page index page for a synopsis of the system of spacetime)

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(see also: "The Particle Table"; "The Intrinsic Motions of Matter"; and "The Higgs Boson and the Weak Force IVBs"; and "The Strong Force: Two Expressions ".)

The Charges of Matter are the Symmetry Debts of Light

Abstract

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

"Noether's Theorem" states that in a continuous multi-component field such as the electromagnetic field (or the metric field of spacetime), where one finds a symmetry one finds an associated conservation law, and vice versa. In matter, light's symmetries are conserved by charge and spin; in spacetime, by inertial and gravitational forces. Light's raw energy is conserved as mass and momentum; light's intrinsic motion or spatial entropy drive is conserved as time and gravitation.

All forms of energy, including the conservation/entropy domain of spacetime, originate as light. During the "Big Bang", the asymmetric interaction of primordial, high

energy light with the metric structure of spacetime (and the unified action of the four forces of physics) produces matter; matter carries charges which are the symmetry (and entropy) debts of the light which created it. Charge invariance is therefore an important corollary of charge and symmetry conservation, maintained in our temporal (gravitational) metric of relative motion by "local gauge symmetry currents" (compensating components of the field vectors, such as magnetism and time). The invariance of "velocity c", the "Interval", and causality are likewise important corollaries of energy conservation (the "Lorentz Invariance" of Special and General Relativity). Charges produce forces which act to return the material system to its original symmetric energy state (light), paying (partially or completely) matter's symmetry/entropy debt. Repayment of matter's symmetry debt is exampled by: 1) spontaneous exothermic chemical reactions and matter-antimatter annihilation; 2) radioactivity and proton decay; 3) the nucleosynthetic pathway of stars and Hawking's "quantum radiance" of black holes. Identifying the broken symmetries of light associated with the charges and forces of physics (including gravity) is the first step toward a conceptual unification. *The charges of matter are the symmetry debts of light*.

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Introduction: Matter

Matter originates through the asymmetric interaction of very high energy light with the metric framework of spacetime (and with the combined action of the four forces of physics); bound electromagnetic energy is a mixture of free electromagnetic energy and dimensional structure. It is thought that the "Higgs" scalar boson is responsible for endowing the weak force IVBs (Intermediate Vector Bosons) with mass, and through the IVBs, also regulating the mass of elementary particles of matter (see below, and: "The Higgs Boson and the Weak Force IVBs: Material Effects").

Light is 2-dimensional while matter is at least 4-dimensional; this dimensional difference is reflected in the differing inertial status of light vs matter - for example, the intrinsic motion of light in space vs the intrinsic motion of matter's time dimension. Massless light is non-local, atemporal, acausal, and does not produce a gravitational field. Massive matter is local, temporal, causal, and produces a gravitational field. Matter's gravitational field creates matter's time dimension. Matter has intrinsic motion in time, whereas light's "clock" is stopped. Conversely, light has intrinsic motion in space, whereas matter has none.

There are two forms of bound energy: matter and antimatter. The two are identical except that their charge and spin-handedness (parity) are reversed. Light has neither charge nor handedness of its own, being a perfectly symmetric energy form in every respect. Hence when light creates particles it can only create particle-antiparticle pairs whose charges sum to zero, since light begins with none. (Light has spin = 1, so it typically creates particle-antiparticle pairs each with spin 1/2 (fermions) but with opposite handedness). Matter and antimatter powerfully attract each other across space by their opposite electric charges, annihilating one another on contact, thus recreating and conserving the energetic symmetry of the light which originally produced them. Our Universe as currently composed consists exclusively of matter, but "in the beginning" it was equal parts matter and antimatter. These equal parts annihilated each other, leaving nevertheless a tiny residue (approximately one part per ten billion) of matter which comprises the galaxies of the current Universe. (The excess of matter is thought to arise from the asymmetric weak force decays of electrically neutral "leptoquarks" - matter and antimatter are apparently not precise opposites (not exactly symmetric) in their interactions with the weak force.)

The term "mass" refers to the quantity of bound energy contained in matter, of which matter's inertial resistance to acceleration (or its gravitational field) is an exact measure. Bound energy is any discrete energy form which does not move freely in space with intrinsic motion c, whose location in spacetime can be specified (whose "Interval" is greater than zero), and which has a time dimension and produces a gravitational field. The term "matter" refers to a specific information characteristic of energy which is more unique than simple quantity: the charge-parity composition which distinguishes matter from antimatter. In the absence of charge and spin, "mass" is indistinguishable from "anti-mass", just as the photon is its own antiparticle, and there is no distinction between energy and "anti-energy". (However, there is "negative energy", of which gravitational energy is the primary example.)

From the perspective of the "Anthropic Principle" (the laws of the Universe must allow the existence of our life form or its equivalent), the role or "reason for being" (rationale) of atomic matter, bound energy, or mass is (at least) fourfold:
1) To provide negative gravitational energy, which exactly balances the positive energy of the "Big Bang", enabling the creation of the material Universe from zero net energy, perhaps as a type of quantum-mechanical fluctuation in a primordial high-tension ("false vacuum") non-dimensional energy field ("inflation" - the "least energy" pathway of Cosmic Creation) (?);
2) To provide a means of compacting energy (including the momentum of mass) in the very early, very small Universe, thereby facilitating the birth of the Cosmos;
3) To provide a carrier and a mechanism for transforming light's immaterial and atemporal energy and symmetry into a material and temporal form of information and symmetry (conserved charges), such that the bound energy of matter can return to free energy even in the absence of antimatter, conserving the energy and symmetry of the light which created it. The elaboration of information systems (including biological systems) is a consequence of matter's search for antimatter and its elemental "memory" (in the form of conserved charges) of the original unity, connectivity, and symmetry of free energy;
4) To escape the vitiating entropy drive of free energy (intrinsic motion c), transforming some of the free energy of the Universe into bound energy, whose entropy drive (the intrinsic motion of time) is of a different character and is insignificant by comparison to c in its destructive effect upon the capacity of bound energy to produce "work". This preserves at least some of the energy of the Universe so that it can be made slowly available (for example, in stars) to do the patient work of evolution, and so allow the Universe to awaken to itself. (See: "Proton Decay and the 'Heat Death' of the Cosmos".)

Matter and its information content are products of the interaction of a symmetric with an asymmetric field - the asymmetric field is embedded from the beginning within the symmetric field as a hidden, latent, or implicit characteristic. With respect to the production of matter: space, light, and the gluons are fundamental symmetric fields, while time, gravity, and the IVBs (Intermediate Vector Bosons) are embedded asymmetric fields. The asymmetric character of the leptonic field manifests only at high energy through the reactions of the weak force IVBs (still seen today in the decays of neutral kaons via the "W" IVB, and as hypothesized during the "Big Bang" in the decays of neutral leptoquarks via the "X" IVB). (See: "The Origin of Matter and Information". See also: "The Higgs Boson and the Weak Force IVBs" for a further discussion of the full energy spectrum of the weak force.)

The System of Matter: Particles

(See: "The Particle Table")

Matter consists of three interrelated classes of particles: 1) the hadrons, or particles containing quarks (composite particles: baryons and mesons); 2) the leptons, or elementary particles (electrons and their heavier kin, and the (almost?) massless neutrinos); 3) the bosons, or field vectors of the charges and forces: the gluons of the strong force; the Intermediate Vector Bosons (IVBs) of the weak force; the photon of the electromagnetic force; and the graviton of the gravitational force. The first two particle classes (the constituents of atomic matter) are known as "fermions", and each class differs in the charges they carry. Hadrons carry color, electric, and flavor charge; massive leptons carry electric and number charge; neutrinos carry only number charge (I often refer to number charge as "identity" charge). All fermions also carry 1/2 integer spin; fermions obey the "Pauli Exclusion Principle", repelling one another. Bosons have whole integer spins, do not repel each other, and can freely superimpose their energies with others of their own kind.

The combination of three particle classes with the four forces of physics is a primary expression of a ubiquitous 4x3 fractal algorithm which evidently organizes the material Cosmos. Another example is found in the three families of 4 elementary particles (see below). It is also expressed as 4 conservation laws connected in triplets, and in other similar formulations involving dimensions, forces, particles, laws, etc. It seems very likely this organizational motif is related to the 3 and 4 dimensional structure of space and spacetime - the structural metric of spacetime is reflected in the structural metric of particles and in the particles themselves: particles are composed of the bound energy of light and reflect the structure of spacetime. This generalized 4x3 system expression apparently originates as the *simplest system of sufficient complexity* to break the symmetry of the primordial particle-antiparticle pairs and so materialize the world. See: "The Fractal Organization of Nature", and "The Information Pathway".

There are three energy levels or "families" of quarks, each level consisting of two quark species, or "flavors": up, down (u, d); charm, strange (c, s); and top, bottom (t, b). (Quarks carry partial or fractional charges, which combine in permanently confined combinations to produce the whole quantum unit charges of the composite baryons and mesons.) There are similarly three energy levels or families of leptons, also in pairs: the electron and electron neutrino; muon and muon neutrino; and the tau and tau neutrino. (Leptons carry whole quantum units of elementary electric and "number" ("Identity") charge). There is currently no explanation for the existence of these 3 energy levels or "families" of paired particles, although it is obvious the heavier families would be useful for storing energy in the extreme density of the early Universe. It is possible they are related through some principle of structural resonance to the 3 spatial dimensions. Ordinary matter, even in the hottest stars, is composed exclusively of the lowest energy level or ground state quark flavors (the proton quark composition is uud, the neutron ddu). It has been suggested that the three energy levels of particles are necessary to produce the primordial asymmetry in the matter-antimatter annihilations of the "Big Bang". (For example, with three families of quarks rather than one, there are many more ways to form electrically neutral leptoquarks and baryons, all of which would be susceptible to asymmetric weak force decays. See: "The Origin of Matter and Information".)

Quarks, leptons, and Leptoquarks

Quarks are the mass carriers (in "hadrons" as baryons and mesons). Baryons consist of three quarks; mesons consist of a quark-antiquark pair. Baryons are the primary mass field because only composite particles can assume the electric charge-neutral configuration (as in neutrons) necessary to the primordial asymmetric reaction producing the cosmic residue of matter (via the presumed asymmetric weak force decay of electrically neutral "leptoquarks").

Leptons and mesons are alternative charge carriers, both for the quark (baryon) system and for themselves. Massive leptons (the electron and its kin) carry electric charge; the electron neutrino and its kin carry the explicit form of "identity" or "number" charge; mesons carry quark flavor, color, spin, and electric charge (partial or fractional charges). Alternative charge carriers permit charge conservation but avoid the annihilation reactions of antimatter; the lepton and meson fields are therefore essential to the expression of the quark field through the baryons, beginning with the leptoquark and its neutrino. Only mesons can carry quark "flavor" and color (or other fractional charges), providing antiquark annihilators which perform quark flavor transformations for the decays of heavy baryons, including proton-neutron transformations ("beta decay" and its inverse). See: "The "W" Particle and the Weak Force Mechanism" and "The Weak Force: Identity or Number Charge".

Leptons and hadrons are presumably related through the (hypothetical) leptoquark, which is a heavy, "fractured" lepton, whose internal structure allows it to assume both a color neutral and an electrically neutral configuration (as in a colorless neutron). During the "Big Bang", this electrical neutrality provided enough time for individual leptoquarks to undergo asymmetric weak force decays rather than paired, symmetric electromagnetic annihilations with their antimatter partners. The slight asymmetry - of unknown origin but consisting of about one part in ten billion - in these electrically neutral weak force decays was nevertheless sufficient to produce the matter residue that comprises our Universe.

The leptoquark is the heaviest member of the leptonic elementary particle series. The leptoquark is essentially a heavy lepton which is fractured into 3 parts (quarks) by the force of the Big Bang, and must forever after remain as a "virtual" elementary particle with whole charge units maintained by the strong force - the confining color charges of its internal "gluon" field (see below). The leptoquark is the "ancestor particle", the common evolutionary origin of the leptons and hadrons, which is why those particle classes carry exactly the same electrical charges and so readily interact with each other. Just as quarks apparently originate from primordially divided leptons, so the gluon field seems to have originated in the same interaction from "split" photons. See: "The Origin of Matter and Information" and: "The Leptoquark Diagram".

Strong Force Gluons

(See also: "The Higgs Boson and the Weak Force IVBs"; See also: "The Strong Force: Two Expressions".)

The quarks of baryons and mesons are held together by a "gluon" field which functions to confine the quarks to whole quantum unit charge configurations. Quarks carry "color" charges, the charge of the strong force, in three "colors": red, green, yellow (not actual colors, only terms of convenience; some authors cite "blue" rather than "yellow"). Gluons are the field vectors or force carriers, the bosons of the strong force. Gluons are composed of paired color-anticolor charges in all combinations, are massless, move at velocity c, and have been compared to "sticky light" (unlike photons, gluons attract each other). There are only 8 active gluon pairs, as the charge combination "green-antigreen" is doubly neutral, and hence nonfunctional. If sufficiently compressed (by the dense metric of the "X" IVB, the "Big Bang", or black holes), the gluon field will sum to zero color and self-annihilate in the limit of "asymptotic freedom" (since it is composed of all possible color-anticolor charge pairs), allowing "proton decay" to proceed like the decay of a heavy lepton, with the emission of a leptoquark neutrino. (See: "The Half-Life of Proton Decay and the Heat Death of the Cosmos".)

The strong force has two structural levels of expression, quite different, one *within* the individual baryon (mediated by a gluon exchange field), and one *between* the individual baryons of a compound atomic nucleus (mediated by a meson exchange field). While the internal baryon level of the strong force consists of an interaction among three quarks carrying 3 "color" charges ("red, green, yellow") exchanging a color-carrying gluon field, the strong force at the compound nuclear level consists of an interaction between two or more baryons carrying 2 quark "flavor" charges ("up, down"), exchanging a flavor-carrying meson field. The gluon field is composed of virtual color-anticolor charges, and the meson field is composed of virtual flavor-antiflavor charges, so the analogy is complete, except that the gluon field is massless while the meson field is massive. The massless gluon field nevertheless produces a short-range force because unlike photons, the gluons attract each other ("sticky light"). (See also: "The Short-Range or Particle Forces".)

Two particle charges unique to the quarks, "flavor" and "color", each produce a version of the strong force, expressed at different structural levels of the nuclear material. The color version of the strong force is expressed within the baryon, producing absolute quark confinement (because symmetry and charge conservation is at risk), while the flavor version of the strong force is expressed between baryons in a compound atomic nucleus, producing a very powerful (but not absolute) binding of baryons within the nuclear boundary (because only a "least bound energy" state is at risk). Both the Yukawa meson exchange field and the Gell-Mann gluon exchange field form "local gauge symmetry currents". The meson field produces the so-called "isospin" or "isotropic spin" symmetry of the "nucleons": protons and neutrons bound together in a sort of hybrid state in compound atomic nuclei, irrespective of their differing "flavor" charges. The gluon field produces the permanent confinement of quarks in massive particles bearing whole-quantum charge units: baryons. (See: "Section XVIII: The Strong Force: Two Expressions".)

Weak Force IVBs (W, X, Y)

(See: "Section XVIII: The Higgs Boson and the Weak Force IVBs".)

The role of the "W" IVBs is to effect transformations of identity among (single) elementary particles (leptons) and of (single) quark flavors among the baryons. The role of the associated Higgs boson is to scale or gauge the mass of the IVBs to an appropriate level, such that they reproduce the original electroweak force unification symmetric energy state of the "Big Bang", which first created and transformed these elementary particles. Transformations are accomplished by combining real particles with appropriate particle-antiparticle pairs drawn from the virtual particle "sea" (the quantum energy fluctuations of the Heisenberg-Dirac vacuum). The "W" forms a bridge between real particles and the virtual particle "sea", making all the charges of the "sea" available to catalyze real particle transformations. (See: "The 'W' IVB and the Weak Force Mechanism".)

The most significant feature of the massive Higgs electroweak scalar and weak force IVBs is that they recreate the original conditions of the energy-dense primordial metric in which particles were created and transformed during the early micro-moments of the "Big Bang". This recapitulation ensures that the original and invariant values of charge, mass, and energy are handed on to the next generation in the charge-transfer chain. The IVB mass not only provides a "safe house" where charge and energy transfers can take place, it simultaneously ensures that the appropriate alternative charge carriers are present, and that the charges and masses of elementary particles are always created from one and the same original, invariant mold.

There is a crucial difference between the creation of particles via particle-antiparticle formation (as by the electromagnetic or strong forces), and the weak force transformation of existing single particles to other elementary forms. The weak force only produces, and is the only force which can produce, "singlet" (unpaired) elementary particles. In the case of particle-antiparticle pair creation, there can be no question of the suitability of the partner for a subsequent annihilation reaction which will conserve symmetry. Universal constants of the spacetime metric and electromagnetism (such as c, h, G, e, etc.) gauge or regulate the invariant mass and charge of particle-antiparticle pairs. However, in the case of the transformation of an existing single elementary particle to another form, alternative charge carriers must be used, since actual antiparticles can only produce annihilations. But how is the weak force to guarantee that the alternative charge carriers - which may be a meson, a neutrino, or a massive lepton - will have the correct charge in kind and magnitude to conserve symmetry at some future date in some future reaction, or with an unknown partner which is not its antiparticle? This is why the "W" IVB must also use particle-antiparticle pairs created from the global spacetime "vacuum" to produce transformations of elementary particles (see: "The 'W' IVB as a Bridge Between 2-D and 4-D Reality").

As an additional measure of safety, and to activate the transformation mechanism of the IVBs, the weak force returns (via the Higgs mass scalar) to the original conditions in which these particles were created, much as we return and refer to the Bureau of Standards when we need to re-calibrate our instruments. The necessity for charge invariance in the service of symmetry conservation therefore offers a plausible explanation for the otherwise enigmatic large mass of the weak force IVBs and their associated Higgs boson. The Higgs and IVB mass serves to recreate the original environmental conditions - metric and energetic, particle and charge - in which the reactions they now mediate took place, ensuring charge invariance and hence symmetry conservation regardless of the type of alternative charge carrier that may be required, or when or where new elementary particles may be created. (See: Global-Local Gauge Symmetries of the Weak Force.)

In these reactions the elementary leptonic field functions as a permanent alternative carrier for the conserved electric and "identity" (number) charges (electrons, electron neutrinos, and their heavier kin), while mesons function as transitory carriers of partial (fractional) quark flavor and electric charges (charged and neutral pions, and their heavier kin). The "Z" IVB mediates certain neutral (uncharged) weak force reactions (usually involving neutrinos) in which two particles simply swap identities or scatter ("bounce") off each other. This is why neutrinos almost never interact - their only pathway of interaction (other than gravity) with another particle is via the massive and quantized weak force mechanism, even in the case of a simple "bounce". (See: "Introduction to the Weak Force".)

The large IVB mass corresponds to a primordial, force unification symmetric energy state (of which there are probably three, each with an associated and distinct scalar Higgs boson), and along with the virtual particle-antiparticle pairs of alternative charge carriers enlisted from the Heisenberg-Dirac virtual vacuum "zoo", form a local gauge symmetry "current" which maintains and protects the invariance of elementary particle mass and charge over the eons of cosmic history and entropy. The IVBs represent primordial, force unification symmetric energy states, and they are so energy dense that they appear to us today as quantized massive particles. Single elementary particles created by the weak force today must be the same in all respects as those created eons ago during the "Big Bang". Hence the necessity for the elaborate, massive, and quantized mechanism of the weak force IVBs and Higgs boson. (See: "Table of the Higgs Cascade.)

The primordial role of the (hypothetical) "X" IVB (the "big brother" of the "W" IVB, gauged by the GUT Higgs boson) is to compress quarks into the leptoquark configuration - vanishing the color charge of the gluon field (in the limit of "asymptotic freedom") - which allows a colorless and electrically neutral leptoquark to decay via the alternative charge carriers of the elementary leptonic field. The very massive X is also involved in proton decay, where electrical neutrality is not required. The W, Z, and X are all "metric" particles derived from (or analogous to) the dense metric of the very early Cosmos; they are "metric catalysts" which produce reactions through dimensional compression. The unusually large masses of the W, Z, and X are due to the enormous binding energy associated with the formation, configuration, and maintenance of their compressed dimensional structure. (Recall that almost all of the mass of a baryon is also due to binding energy, not to the actual mass of the quarks themselves.) It is this dimensional structure (which is possibly also unusual in terms of its topology, geometric configuration, or number of dimensions) which relates the IVBs to some of the multidimensional particle structures currently under investigation by "String" theory. The IVBs may be unrecognized "strings", or their analogs.

An Heuristic Analogy Borrowed from Biology

Another way to think of the transformation mechanism of the weak force IVBs is to employ an analogy from the taxonomic hierarchy of biology. If we think of the various quarks and leptons as individually distinct "species", then the IVBs may be thought of as representing or creating a "genus" level of particle identity - a higher symmetric energy state in which the electromagnetic and weak forces are joined into the "electroweak" unified-force symmetric energy state. In this E/W unified state the individual quark species are subsumed into a "generic" level of identity ("hadrons"), where all quark species are equivalent and any one can replace any other. The same holds true for electrons, electron neutrinos, and their heavier kin ("leptons"), but at the electroweak energy level the quark "genus" and the lepton "genus" remain distinct. The next higher force-unity symmetric energy state is the GUT ("Grand Unified Theory") in which the quark and lepton genera are joined at a "family" level of merged identity. This GUT level is represented by the "X" IVB, which mediates "proton decay" and the interchange of lepton and quark species identities (in "leptoquarks"). At the GUT symmetry level, however, the "fermion" and "boson" families remain distinct. (Bosons are the force carriers or field vectors of the forces - photons, gluons, gravitons, IVBs.) The final force-unity symmetric energy state is represented by the "Y" IVBs and the "TOE" ("Theory of Everything") or Planck energy level. This corresponds to the joining of the fermion and boson "families" into the "order" of electromagnetic energy forms. At this final energy level, bound and free forms of electromagnetic energy are exchanged, mass is created, and the structure of the electromagnetic metric is carried into particles. At each force-unity level, transformations take place naturally because at that energy level the distinctions between particles either no longer exist or

> are insignificant. While the IVBs represent the actual transformation mechanism, Higgs bosons (one at each level) select and scale the energy state appropriate to a given transformation. (See: "Table of the Higgs Cascade".)

In addition to the operation of the IVBs and the alternative charge carriers of the meson and elementary leptonic field, there must be a fundamental asymmetry in the rate of decay of electrically neutral leptoquarks vs anti-leptoquarks to produce a residue of matter during the Big Bang. The source of this fundamental temporal asymmetry is not understood, but without it the Universe of matter cannot manifest, as it simply self-destructs through completely symmetric matter-antimatter annihilations. Matter is only as complex as is necessary to break the primordial symmetry of the particle-antiparticle pairs during the Big Bang - no more; but even that level of minimal sufficient complexity produces beings like ourselves, over evolutionary time.

Note: The leptoquark, its neutrino, and the X particle are hypothetical (predicted). I have had to include them to join the leptons and quarks, and to make sense of the other standardly recognized parts of the "System of Matter", which are not hypothetical, but nevertheless lack a unifying theory regarding their common origin. (See: "The Particle Table".)

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