

Unification Era	Symmetry Group, Higgs	IVBs (Decay Path)	Field Vector Temp/Time/GEV	Charge Symmetry Debt	Era Role
Planck Era; T.O.E. "Theory of Everything" (Gravity and Spacetime Unified with Light, Particles); Creation of Massive Leptoquarks	Higgs 3; All Forces Unified; G2 (?) (Massive Leptons and Leptoquarks); Gamow's "Ylem"; "Quark Soup"	"Y" IVBs; Create/Destroy Charged and Neutral Leptoquarks	Graviton (Gravitational Force); 10(32) k; 10(-43) sec. 10(19) GEV; (Rebound: "Big Crunch")	"Location" (gravitational charge); Negative Energy/Entropy; Total Energy/Entropy = 0; "Local" Mass Distribution Asymmetry	Negative Gravitational Energy; "Ylem"; Create Massive Leptons, Leptoquarks; Time; ?Inflation?
Leptoquark Era; G.U.T. "Grand Unified Theory" (Quarks Unified with Leptons); Asymmetric Leptoquark Decay; Creation of Matter, Hyperons	Higgs 2; Strong, EW Forces Unified; SU(5); (Electrically Neutral Leptoquarks Only)	"X" IVBs; Transform/Destroy Neutral Leptoquarks; Create/Destroy Matter Hyperons; Matter/Antimatter Symmetry-Breaking; "Proton Decay"	Gluon (Strong Force); 10(28) k; 10(-35) sec. 10(16) GEV; (Rebound: Supernova, Black Hole)	Color Charge; Total Color = 0; Partial Charge Asymmetry of Quarks; "Asymptotic Freedom", Quark Confinement	Asymmetric Decay of Leptoquarks Creates Matter, Hyperon "Singlets", Leptoquark Neutrinos; Dark Matter (?)
Hyperon Era; EW Electroweak Union (Quarks Unified, Leptons Unified); Creation of Lepton/Meson Alternative Charge Carriers	Higgs 1; Weak, EM Forces Unified; SU(2), SU(3) (Leptons, Quarks)	"W" IVBs; Transform Hyperons; Create/Destroy/Transform Alternative Charge Carriers (leptons, mesons, neutrinos)	IVB (Weak Force); 10(15) k; 10(-10) sec. 10(2) GEV; (Rebound: Stars, White Dwarf, Neutron Star)	"Identity" ("Number") Charge; Total "Number" = 0; "Identity" Asymmetry of Leptons, Baryons, Fermions	Creates, Destroys, Transforms Single Leptons, Neutrinos, Quarks; Transforms Single Baryons
Atomic Era EM Electromagnetic Unification; Electric/Magnetic Fields Unified; Creation of Atoms,	EM "Ground State"; Spacetime Metric (Scaled by c, G); U(1) (Phase)	Photons; Create and Transform EM Fields, Space and Time; Create/Transform Chemicals, Molecules,	Photon (Electromagnetic Force); (currently) Temp. 2.7 K; Historic Spacetime; 13.7 Billion Yr.	Electric; Total Electric Charge = 0; 4th Dimension One-Way Asymmetry (Time)	Creates Spacetime, Information, Atoms, Life; "c" Gauges Metric and Virtual

Information, Spacetime	(Light) (Photons)	Information	10(-3) EV; (Rebound: Planets)	Particle "Sea"
Higgs Table No. I: Unified Force Eras or Symmetric Energy Levels of the "Big Bang"				
J. A. Gowan and A. T. Jaccaci (revised, Nov., 2012) http://www.johnagowan.org/index.html				
"Multiverse": Non-dimensional "vacuum" source of undefined symmetric energy and creative potential - produces our 4-D universe as a quantum fluctuation of <i>no net energy or charge</i> , conserving energy, with "life-friendly" physical constants ("Anthropic Principle"). Balanced pos-neg (gravitational) energy and matter-antimatter charge symmetry. (Cosmos, Multiverse united). "Big Bang": Cosmos devolves from "Multiverse".				
Information and Biological Eras evolve as ground state "rebounds" from entropy-driven "Higgs cascade". Rebound is driven by symmetry conservation, negentropic gravity, and evolutionary forces, creating planets, stars, black holes, galaxies, "Big Crunch", heavy elements, chemistry, information, life, humanity. (See Also: " Table of the Unified-Force Eras of the Cosmos ".)				

THE HIGGS BOSON AND THE WEAK FORCE IVBS (INTERMEDIATE VECTOR BOSONS): PART IV: TABLE OF THE HIGGS CASCADE

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Abstract

We explore the hypothesis that there are 3 "families" or energy levels of the Higgs bosons and their associated Intermediate Vector Bosons (IVBs), analogously to the three families or energy levels of the quarks and leptons. With its origin in the "Multiverse", our Universe apparently devolved (rapidly) downward in an asymmetric "Higgs Cascade" to the electromagnetic ground state, and now evolves (slowly) upward again in a "rebound" driven by negentropic gravity and symmetry conservation (Noether's Theorem), back to the Multiverse state (in a "Big Crunch" gravitational cosmic collapse) or to a state of pure electromagnetic radiation (light). CERN announced the discovery of a Higgs-like boson on 4 July, 2012 (energy level

~126 GEV).

Unification Eras (or Symmetric Energy States) of the "Big Bang":

Force-Unity Eras: Multiverse Era

[Multiverse Era](#): Non-dimensional, "vacuum" potential of undefined creative energy, producing infinitely (?) many energy-conserving Universes (with various and unique physical constants) via quantum fluctuations of *no net energy or charge*, one of which (constrained by the "Anthropic Principle") becomes our own. Below, scalar Higgs particles, "Standard Model" symmetry groups, transformative IVB families, and field vectors of the four forces are listed for an entropy driven decay "cascade" through 4 successively diminishing levels of force unification. Major roles and productions of the eras are suggested. Except for the final EM "ground" state, unification eras correspond to a specific temperature (absolute degrees Kelvin) and time period (after "time zero") of the "Big Bang" decay sequence (For table data see: Brian Greene: *The Fabric of the Cosmos*, P. 270, Knopf, 2004, and Frank Close: *The New Cosmic Onion* Taylor and Francis, 2007, page 196. For symmetry discussion, see : Ian Stewart, *Why Beauty is Truth*, P. 239-73, Basic Books, 2007). For a discussion of the Higgs boson, see: Sean Carroll: *The Particle at the End of the Universe*, Dutton, 2012

Force-Unity Eras: Planck Era

3) [Planck Era \(quantum gravity era, primordial "Ylem" era\)](#). Y+, Y-, Y (neutral) IVBs; Higgs 3 (or "Higgs y"), - TOE unity (Theory of Everything): unified positive electromagnetic and negative gravitational energy ("Yin-Yang"). All forces unified. 10^{32} k; 10^{-43} sec. Unified gravity, light, spacetime, and bound energy forms (primordial, electrically charged leptons; charged leptoquarks

(a leptoquark is a trisected heavy lepton, the mass limit of the leptonic spectrum). "Quark soup", "quantum gravity". Negative gravitational energy exactly balances positive electromagnetic energy. Matter-antimatter symmetry. Primordial, massive, charged leptons are produced by the combined action of all forces. "Y" IVBs transform electrically charged leptoquarks into electrically neutral leptoquarks, creating the possibility of matter-antimatter symmetry-breaking. Neutral leptoquarks will decay further in level 2 (Leptoquark Era). Matter-antimatter annihilations. *(Creation of primordial leptons, particle mass, and leptoquarks; "Big Bang" Creation Event; separation of Universe from Multiverse. Creation of bound electromagnetic energy (massive particle-antiparticle pairs) from free electromagnetic energy (light). Coding and conservation of light's symmetry, energy, and entropy parameters as the charges, spin, mass, and time of particles. Rebound = "Big Crunch".)*

Force-Unity Eras: Leptoquark Era

2) [Leptoquark Era](#). X^+ , X^- , X (neutral) IVBs; Higgs 2 (or "Higgs x"), - GUT unity (Grand Unified Theory). Electrically neutral leptoquarks only. Separation of the spacetime metric (including gravity) from primordial leptoquarks, and the beginning of the entropic expansion and cooling of the Cosmos. This separation may correspond to the "inflationary" era of Guth and Linde (?). Strong and electroweak forces unified. Quarks and leptons combined but with separate spacetime and gravity. $10(28)k$; $10(-35)$ sec. Quark partial charges allow the existence of electrically neutral leptoquarks. "X" IVBs compress neutral leptoquarks, causing color charge to self-annihilate in the limit of "asymptotic freedom". With conserved color charges absent, weak force decays proceed (via the "X" IVBs) with the emission of leptoquark neutrinos. Asymmetric weak force decay of electrically neutral leptoquarks vs antileptoquarks

produces level H1 Hyperon Era and matter asymmetry of Cosmos. (*Transformation of leptiquarks. Asymmetric creation of matter and single hyperons; leptiquark antineutrinos are "dark matter" candidates. "Proton decay". Rebound = black holes.*) (For "inflation" hypothesis, see: Alan H. Guth *The Inflationary Universe* Helix Books 1997.)

Force-Unity Eras: Hyperon Era

1) [Hyperon Era](#). W^+ , W^- , W (neutral) IVBs; Higgs 1 (or "Higgs w"), - EW unity (Electroweak Unification): hyperons (heavy baryons) and heavy leptons. Weak and electromagnetic forces unified. $10(15k)$; $10(-12)$ sec. Matter-only asymmetry. Leptons and quarks separate into unified lepton "genera" and unified hadron "genera". "W" IVBs transform quarks into other quarks and leptons into other leptons (but not leptons into quarks). Hyperons and heavy leptons decay (via "W" IVBs) to "ground state" proton, neutron, electron, and photon with emission of leptonic antineutrinos. Leptons, mesons, and neutrinos serve as alternative charge carriers for the decays of hyperons and heavy leptons, avoiding antimatter annihilation reactions. (*Creation of leptons, neutrinos, mesons - alternative charge carriers; creation of leptonic "singlets". Transformation of baryons. Rebound = Stars*)

Atomic Era: "Ground State"

[Atomic Era. Cold "Ground State"](#). Free-ranging photons; creation of large spatial and temporal dimensions. Bosons, leptons, hadrons - EM unity (Electromagnetic Unification). Spacetime, light, and gravity remain unified, electric and magnetic fields remain unified. Heisenberg/Dirac virtual "vacuum" particle "sea". Photon separates from "W" IVBs, creates and energizes space; gravity creates time from space, time creates history. Photons and the spacetime metric are the ground state (dimensional) analogs of the Higgs and IVB "particle metric". Era of atomic matter, information, light,

gravity, and spacetime. (*Creation of space, time, atoms. Rebound = Planets.*)

The "Ground State Vacuum" also hosts virtual particle-antiparticle pairs, which are essential for maintaining an active connection between the electromagnetic ground state and higher energy electroweak transformations, (for example, the transmutation of atomic nuclei in "radioactive" decays and during element-building in stars during the early "rebound phase"). Both processes (fission and fusion) directly and continuously interact with the electromagnetic ground state, whereas interactions at the GUT and TOE energy levels are typically of one-time historic significance (creation of Universe, creation of matter). Neutrino "flavor" oscillations may be an example of a remnant union from the more symmetric EW era.

Symmetry Restoration or "Rebound" Era

Ground State "Rebound" Information, life, and consciousness era, including humanity, symbolic information, and technology. Driven by symmetry conservation, negentropic gravity, and biological evolutionary forces. Rebound begins with planets (ground state); continues through sun-like stars and neutron stars (level H1); supernovas, quasars, and black holes (level H2); and cosmic collapse or "Big Crunch" (level H3). *Creation of planets, stars, black holes, the "Big Crunch"; heavy elements, molecules, chemistry, life, conscious experience, symbolic information, technology, humanity, novel forms of creativity and beauty.* (See: "Nature's Fractal Pathway".)

We have previously (and correctly) understood the gravitational rationale from the point of view of: 1) energy, entropy, and causality conservation (the gravitational creation of time from space, providing the temporal entropy drive and causal linkages for bound energy); 2) the point of view of symmetry conservation (the gravitational conversion

of bound to free energy, as in stars); 3) as the source of negative energy (balancing positive electromagnetic energy) in the "Big Bang". (See: [Entropy, Gravitation, and Thermodynamics](#)). The gravitational recapitulation of force unification and symmetry states (culminating in the "Big Crunch") allows us to understand the gravitational rationale from a new, fourth perspective embracing only the reunification of the four forces.

Rationale for the Higgs Boson

[The role of the weak force in the cosmic scheme](#) is to create, destroy, or transform *single* elementary particles. [An asymmetry in the action of this force](#) is thought to be responsible for the production of our "matter-only" universe. The Higgs boson is necessary to gauge (determine, standardize) the rest mass energy of the IVBs and the elementary leptons and quarks, so their masses will have a defined and invariant magnitude, reproducible everywhere and anywhen in time and space. This is the grand "local gauge symmetry" of the weak force and the *single* elementary particles it produces. An electron created today can be "swapped out" with any other in the Cosmos, no matter when or where it was produced, including in the "Big Bang" (hence exact antimatter annihilation partners can also be produced, when required, as for energy/symmetry conservation). The Higgs acts through its IVBs to gauge the elementary particle masses. The large Higgs and IVB masses reproduce the force-unity energy levels in which these particles were first made (the electroweak force-unity energy level in the case of the "W" IVBs). Thus every elementary particle is forged from the same original mold, and every weak force interaction involving the IVBs is a mini "Creation Event". Moreover, the massive Higgs is also thought to stabilize the universe against collapsing into a black hole during the "Big Bang" (see cite below). The Higgs and IVBs must be massive to prevent the attenuation of their energy content during the entropic expansion of the cosmos over its lifetime. Regarding the inertial mass of particles as measured by resistance to acceleration ($F = MA$), see: ["The Higgs Boson vs the Spacetime Metric"](#).

The anomalous parity violation of the weak force is due to the absence of antimatter. Lacking other distinguishing charges, left vs right "handedness" is the only way neutrinos are differentiated from antineutrinos - all matter neutrinos have left-handed spin and all antimatter neutrinos have right-handed spin. In our matter-only universe, the weak force can only interact with left-handed electrons (for example), because the electron neutrinos which carry the electron's leptonic "number" or "identity" charge (the alternative charge carrier) is perforce exclusively left-handed.

Like other charges, "handedness" must either be conserved as it is, or neutralized by its opposite. When an electron is created, its leptonic "number" or "identity" charge must be neutralized by an accompanying antineutrino, which however can only have right-handed spin, forcing the electron (which ordinarily can have either handedness) to have the opposite and balancing left-handed spin. When this electron is subsequently destroyed in some later weak force reaction, its number charge must be conserved (carried forward as is) by a (matter) neutrino, which of course can only have left-handed spin. Hence we see the parity charge "left-handedness" carried through the creation and destruction of (matter) electrons, first by the electron itself, and then by its neutrino. Thus arises the weak force violation of parity, coupling only to left-handed particles, an asymmetry which would be completely reversed if our world were made of antimatter.

References

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Links to other parts of this paper:

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The role of the Higgs boson in this process is to gauge or scale the IVBs to the proper energy level or mass so that they become part of a specific force unification regime where the transformations they perform are: 1) a natural characteristic of the symmetry state; 2) invariant in their output. The IVBs are necessary to actually perform the transformations; the Higgs is necessary to select the proper IVB family, and to ensure the invariance of their product. (See also: The Higgs Boson and the Weak Force IVBs.) Weak Force Reactions. Below I list all the major examples of the slow or "weak" reactions as recorded in the "Stable Particle Table" of the 65th CRC Handbook of Chemistry and Physics. The relationship between the Higgs boson and the weak force intermediate vector bosons. The IVBs (Intermediate Vector Bosons) are the field vectors (force carriers) of the weak force. The IVBs reconstitute (or revisit) the energy dense, early metric of spacetime (during the "Big Bang"), and their mass is the probable consequence of the binding energy necessary to condense, compact, and/or convolute the spacetime metric to a particular symmetric energy state, defined by a specific force-unification era (such as the Electroweak Era, for instance), with a specific energy density and temperature. The "Higgs Cascade" model presumes three energy levels, tiers, or "families" of IVBs, each with an associated and distinct Higgs boson. The experimental profile of the Higgs boson. The principal decay channels to vector bosons. Decays to third generation fermions ($b\bar{b}$ and $\tau\bar{\tau}$). Higgs boson production in association with top quarks or in top decays. Higgs boson pair production. Searches for rare decays of the Higgs boson. Searches for non-SM decay channels. The Higgs boson is anyway special and, in the eight years since its discovery, it became a powerful tool to explore the manifestations of the SM and to probe the physics landscape beyond it. It might offer direct insights on what comes beyond the weak scale through possible sizeable effects on the Higgs boson properties. The Higgs boson couplings, however, are observed to be in good agreement with their SM predictions. Cascade decays of heavy leptons, quarks, virtual photons, weak vector bosons and Higgs scalars are discussed in the standard $SU(2)_L \times U(1)_Y$ gauge model of Glashow, Salam and Weinberg for weak and electromagnetic interactions with a strong emphasis on the possible existence of more than three generations of leptons and quarks. In particular, the possibility of tremendously high multiplicities of resultant ordinary leptons and quarks in such decays is demonstrated as an important clue to future experimental searches. A booklet is available containing the Summary Tables and abbreviated versions of some of the other sections of this full Review. [View](#). [Show abstract](#). The masses of the weak vector bosons and physical Higgs scalars are related to those of leptons and quarks. The Higgs boson is a particle that was hypothesized in 1964 by Peter Higgs and other theoretical physicists who were trying to understand the origin of the mass of fundamental particles. We know from elementary physics that the mass of an object is the resistance it offers to have its motion changed as described by Newton's law $F=ma$. This field exerts a drag force on particles when they accelerate through it. This resistance to the increase of the acceleration of a particle is the particle's mass. As an analogy, we can think about moving an object in the water.