

Global-Local Gauge Symmetries and the "Tetrahedron Model" Part III: Postscript

John A. Gowan

[Homepage](#)

(Revised Jan., 2013)

Related Papers:

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part I\)](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part II\)](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(Postscript\)](#)

[Global-Local Gauge Symmetries in Gravitation](#)

[Global-Local Gauge Symmetries in the Weak Force](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part IV\)](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part V\)](#)

Table of Contents

[Introduction](#)

[Global vs Local Gauge Symmetries](#)

[Global-Local Parameters in the Electromagnetic Force](#)

[Summary](#)

[Links](#)

[References](#)

Introduction: Duality in Nature

[Go to "Global and Local Gauge Symmetry: Part I"](#)

[Go to "Global and Local Gauge Symmetry: Part II"](#)

From ancient times we have intuited and named a dual level of reality - it is a defining characteristic of abstract thinking, symbolic language, and the human condition. This recognition of abstract reality has its most explicit social expression in our religious (and political) systems of thought, the realm of the gods (and the State), religious and secular law vs the realm of humanity and the "citizen". Plato recognized it as the realm of ideal forms vs the realm of their material "shadows". Duality takes additional forms in philosophical, ethical, moral, and aesthetic conceptual systems. In our own physiology, in addition to the biological duality of gender, we seem divided between the intangible realm of thought and imagination and the realm of physical action and the body (mind-brain). In science we recognize dualities between the realm of physical or natural law vs the realm of phenomena, the theoretical vs the experimental, mathematics vs material reality, symbol vs substance, and virtual or potential vs actual or realized forms of energy, among many other types of duality.

A significant duality in mathematical physics is expressed as "global vs local gauge symmetry" - a methodology of conceiving the laws and phenomena of physics that is especially conducive to mathematical formulation ("group theory"), and is currently the favored theoretical approach in the ongoing search for the "Holy Grail" of physics, Einstein's dream of a unified field theory.

The world is a mysterious place, and not just in terms of the enduring question of humanity's role in the Cosmos. We find in all natural phenomena a variety of "hidden", relative, or emergent forces. This is nowhere more evident than in the paradoxes of relatively and quantum mechanics, enigmas at the very foundations of physics (spacetime warps, "non-locality", etc.).

At the level of the four forces, we have the mysteries of gravitation, time, and magnetism in the long-range, "spacetime" forces. These are local effects set against and derived from the global invariants of electromagnetism: "velocity" c , a symmetric spatial metric, and electric charge. In the particle or short-range forces, we find the hidden "identity" or "number" charges of the massive leptons, the Heisenberg-Dirac virtual vacuum "zoo" of particle-antiparticle pairs, and the strange realm of the weak force, with its massive IVBs, Higgs boson(s), ghostly neutrinos, spontaneous symmetry-breaking, the creation and destruction of matter, etc. Finally, in the strong force we have the permanently confined and forever hidden quarks with their partial quantum unit charges, and the gluon field of "sticky light", exchanging color charges between quarks at velocity c .

The atomic realm is a hive of activity completely beneath our notice - the whirling electrons in their orbits, the exchange of virtual mesons between "nucleons" in the compound atomic nucleus, and the frenzied exchange of gluons between quarks within baryons. The "vacuum" bubbles and froths with the creation and annihilation of Heisenberg's virtual particles; neutrino, gravitational, and electromagnetic waves of every description traverse the Cosmos unrecognized - either for lack of biological sensory apparatus or physical interaction. Yesterday, historical spacetime, and the "realm of the ancestors" is largely hidden from our view, even though its continuing reality in some alternative, causal form cannot be doubted - as it sustains our own reality today in the "universal present moment", or "now". Our "yesterday" forms part of "today's" reality in some distant part of our universe - and vice versa. (See: ["A Spacetime Map of the Universe"](#).)

These are some of the documented, rational, "scientific" physical phenomena, and I have only mentioned the tip of the iceberg, ignoring "dark matter", "dark energy", "inflation", the "Multiverse", etc. Is it any wonder we have intuited a hidden, parallel, "occult" universe of paranormal effects and miracles, of gods, angels, and demons? Of "Paradise" or "Heaven", a conservation domain of spirit and the eternal realm of invariant Divine Law - where all humanity finds itself in a globally symmetric state of universal spiritual equality?

Global vs Local Gauge Symmetries

Global symmetries are those that apply everywhere, and for all time, such as the electric charge, mass, and spin of an elementary particle. This is a symmetry only because all electrons (for example) everywhere and always have exactly the same electric charge, mass, and spin - any electron could be swapped with any other without causing the least disturbance to the universe. Other global symmetries include the value of the universal electromagnetic constant "velocity c ", the value of the universal gravitational constant "G", the value of Planck's energy quantum (h), among many others. These physical constants or physical global symmetries never change and are determined, fixed, set, or "gauged" at the beginning of the universe. They are the defining parameters of our universe, distinguishing it from any other in the "Multiverse".

Local symmetries, on the other hand, involve actual changes in a single particle from one globally conserved symmetry state to another, as in the decay of a single neutron to a proton, electron, and electron anti-neutrino. In such a decay, all the original charges must reappear (in some form) in the product particles, and both the original and product particles must themselves be members of some global symmetry set or state. Finally, such locally gauged symmetry changes are, at least in principle, reversible given sufficient energy. Local gauge symmetry interactions involve post-"Big Bang" interactions between particles (or dimensions), and are mediated by the field vectors of the four forces of physics. They are the conserved interactions between particles (or the metric) that produce

the common environment of our daily experience.

While the title of this paper may sound formidably obtuse, it is typical physics/math-speak for a simple but powerful idea: the value or magnitude of certain universal constants, such as the electromagnetic constant "c" and charges of all kinds, must be maintained and protected, for excellent and obvious reasons of conservation, including energy, symmetry, and causality. This is not a particularly difficult task in the perfect realm of light and space, where in the absence of matter, time, and gravity, all velocities are "c", all charges are virtual, and all energy forms are non-local and massless. In our actual, compounded world of free and bound types of interacting electromagnetic energy, however, we find (in addition to light) massive particles bearing various real charges, having specific locations in spacetime, and moving with various relative motions. Time and gravity are also present wherever matter is present.

In this highly complex "real" rather than "ideal" world, maintaining the constant value of c and various charges, etc., is a difficult but nonetheless necessary task, requiring some extra help from ancillary forces which have come to be known as "local gauge symmetry forces". Because it is the real world and not the ideal world we ordinarily inhabit, these local forces are among the most familiar of our daily experience: gravity, time, and magnetism, among others.

The concept of symmetry is central to the modern effort to achieve Einstein's dream of a unified field theory of physics. I have used the concept extensively in my work (See: "[Symmetry Principles of a Unified Field Theory](#)"), but from a slightly different perspective than that of "establishment" physics. (See: *The Moment of Creation* by James S. Trefil, 1983, Macmillan, pages 87-125 for an expert but non-mathematical explanation of the use of symmetry concepts in the "standard model" of unification physics.)

Although the global-local gauge symmetry concept is often couched in purely numeric terms of the universal vs the individual, for reasons of physical relevance I have broadened this usage to include the category of absolute motion vs relative motion. As I employ the terms, absolute stands to relative as global stands to local or as the universal stands to the individual. The relative is unpredictable and peculiar to the individual. The task of local gauge symmetries is to maintain within the temporal, unpredictable, individual, and relative material domain some essential, conserved aspect of the global invariant - for example, the invariance of the magnitude of electric charge despite the freedom of relative motion of individual massive charge carriers (electrons, protons, mesons, etc.).

Mathematical physics distinguishes between the concepts of "global" vs "local" gauge symmetry: "local" gauge symmetries are derived from and represent individual variations upon universal or "global" gauge symmetries. The word "gauge" refers to a regulating property that establishes a magnitude or scale, as for example the value of the electromagnetic constant (c), a global symmetry gauge for electromagnetic energy and the spatial metric. The magnitude of the electric charge (e), Planck's energy constant (h), the value of the universal gravitational constant (G), and the mass of the Higgs boson, also represent global gauge constants established during the "Big Bang" at the creation of our universe. On the other hand, a magnetic field, the time dimension, the massive IVBs (Intermediate Vector Bosons) of the weak force, and the gluon/meson fields of the strong force, are all local gauge "currents" of matter (field vectors of the forces) which establish and maintain local gauge symmetries in the post-"Big Bang" universe. Cold, crystalline, and neutral atomic matter is the prototypical example of an energy form established and maintained by "local gauge symmetry currents" from a globally symmetric energy form - light.

Light (free electromagnetic energy) is a globally symmetric energy state from which locally asymmetric atomic matter (bound electromagnetic energy) is devolved. The charge neutrality and

inertial stasis of cold, quiescent atomic matter is the evidence of a locally symmetric energy state, involving charge conservation and neutralization, alternative charge carriers, and inertial forces, which is achieved or derived from, and replaces, the globally symmetric energy state of light. In many respects, the local symmetry state is just as invariant and conserved as the global one, and in fact the two regimes are in constant interaction and equilibration (through virtual particles and other quantum effects of the spacetime "vacuum", long-range electromagnetic and gravitational fields, etc.). However, the fact that forces are at work in our local environment (gravity is the obvious example, in our experience of "weight" and the radiance of our Sun; radioactivity is another example), tells us that the two systems of light and matter are not yet in a state of complete equilibrium.

The reason why we have a dual system of global vs local gauge symmetries in physical law and phenomena is because our Universe consists of massive, local energy forms in relative motion (matter), which are derived from light - a massless, non-local (global) energy form in absolute (invariant) motion. Functionally, the local symmetries are embodied and enforced through the field vectors of the forces. The field vectors translate timeless global symmetries (such as the virtual charges of matter-antimatter particle pairs) into alternative, material, local, temporal forms (such as the real charges of atomic matter). These local charges conserve the invariant values of the original global symmetries through time, until they can be returned (via the action of their associated forces) to their original symmetric form, light (typically via charge-anticharge annihilations).

Through an (as yet) unknown mechanism of "spontaneous symmetry-breaking" during the "Big Bang", high-energy light, interacting with the metric structure of spacetime and with all the four forces of physics, produces matter (from particle-antiparticle pairs via asymmetric weak force decays, probably of electrically neutral [leptoquark-antileptoquark pairs](#)). Matter carries active charges (and spin) from one member of the primordial particle-antiparticle pair, charges which represent symmetry debts (since charges exist only to motivate and facilitate annihilation reactions between particle-antiparticle pair members, restoring light's waveform or "non-local" symmetry state). *The charges of matter are the symmetry debts of light* (Noether's Theorem.) These charges produce forces which act to return matter (sooner or later) to its original symmetric form, light. Our Sun is the archetypical example of this universal phenomenon and natural agenda in action (symmetry conservation as required by Noether's Theorem, and achieved by the spontaneous activity of the forces of physics).

While the ultimate role of the field vectors of the four forces is to return matter to light, their proximate role is to translate globally invariant symmetries into locally invariant charges. The reason why they bother to do this is because in the absence of antimatter (following "Big Bang" symmetry-breaking), local symmetry-keeping and charge conservation is a necessary maintenance function in the pathway leading to the eventual and complete restoration of light's original symmetric non-local energy state - a restoration required by symmetry conservation and Noether's Theorem.

The charges of matter are derived from invariant global gauge symmetries, and their field vectors (including the graviton, or time) represent local gauge "currents" establishing and maintaining similarly invariant local charge magnitudes. The field vectors, in addition to transmitting the forceful effect of the charge, must also protect, conserve, or otherwise maintain the invariant magnitude of the charge. Symmetry conservation = charge conservation, which is why charge invariance is so important. Charge and symmetry conservation would have little meaning if charge invariance was not rigorously enforced. This is why all field vectors, in dealing with the relative energy state of matter, must have a flexible component or capability, like the photon's magnetic field, whose strength varies with the relative motion of electric charge. The flexibility of the local component is what protects the inflexible (invariant) global component in the unpredictable and turbulent domain of matter and relative motion.

Mathematical physics uses symmetry principles to obtain quantitative equations describing the

operation of the forces, and for predictions and explanations of experimental results. I use the concepts of symmetry in a non-mathematical, qualitative way to understand why the forces act as they do, and why they must exist in nature. The concepts of symmetry, when properly applied, provide a broad avenue to the understanding of nature - equivalent to the fundamental and powerful ideas of entropy, causality, and energy conservation (See: "[The Tetrahedron Model](#)"). Both establishment physics and I have been successful in our own ways. This paper (and others in the global-local gauge symmetry series) is an attempt to join the perspectives of the "Tetrahedron Model" and the "Standard Model", not mathematically (because that desideratum is quite beyond my ability), but conceptually, in English. (See also: [The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison.](#))

Global-Local Parameters in the Electromagnetic Force - General Considerations

The conversion of light to matter, free electromagnetic energy to bound electromagnetic energy, during the "Big Bang", represents the conversion of a globally symmetric form of energy (matter-antimatter symmetry, space, and massless "non-local" light with intrinsic spatial motion "c") to a locally asymmetric form of energy (matter, time, and massive local particles with no (net) intrinsic spatial motion). In purely energetic terms, this conversion is symbolized by DeBroglie's equation: $h\nu = mcc$. For simple reasons of conservation, a local form of energy (massive particles of matter) requires a local form of entropy (time), a local form of symmetry (charge), a local form of metric (gravitational spacetime), a local connectivity domain (history, causality). Charge invariance with whole quantum charge units, the invariance of velocity c, the "Interval" and causality, and the invariance of elementary particles: all are conservation mandates which follow upon the transformation of free to bound electromagnetic energy during the "Big Bang", and which necessitate the existence of various sorts of local gauge symmetry currents to cope with and compensate for local conditions of relative motion, variable gravitational metrics, etc.

The original and primordial global-local conversion of our primary electromagnetic energy form (light), is accompanied by the [gravitational conversion of globally symmetric space](#) with its spatial entropy drive (the intrinsic motion of light), to locally asymmetric history with its historical entropy drive (the intrinsic motion of time). Finally, light's symmetric energy state, which is realized (in its particle form) as globally symmetric matter-antimatter particle pairs, is converted (quantum-mechanically through an asymmetry in the weak force), [to locally asymmetric matter-only charges](#).

Charge conservation = symmetry conservation (Noether's Theorem), in which charges are carried by massive particles and conserved through time. The conserved charge-symmetry debt of matter is fully repaid when charges are eventually annihilated by antimatter charges. The "entropy-interest" on matter's symmetry debt is paid by gravitation, which creates the time dimension of matter by the annihilation of space and the extraction of a metrically equivalent temporal residue. The spatial expansion of the Universe is consequently slowed as it supplies energy for the historical expansion of matter's causal information domain - historic spacetime. Thus it is ultimately the spatial entropy drive of light's intrinsic motion which supplies the energy for the historical entropy drive of matter's time dimension. This energy cycle "loops to ground" by the gravitational conversion of bound to free energy (and the consequent conversion of the historical entropy drive of time to the spatial entropy drive of light) in the Sun, stars, and quasars, and goes to completion in Hawking's "quantum radiance" of black holes.

Light is non-local, atemporal, acausal, massless, chargeless, and [produces no gravitational field](#). Matter is local, temporal, causal, massive, charged, and produces a gravitational field. The conversion of globally symmetric light to locally asymmetric matter results in matter's three fundamental and local conservation parameters: mass, charge, and time. (See: [The Tetrahedron Model](#) (diagram).)

Summary

The magnetic field associated with an electric charge in relative motion is the transformed motion of the charge's electrical field to an alternative electromagnetic form which does not alter the original magnitude of the electric charge. The magnetic field functions to protect the invariance of electric charge in relative motion, hence also protecting charge and symmetry conservation. Magnetic effects can be seen as related, ancillary consequences of the "Lorentz Invariance" of Special Relativity, in which the local flexibility and covariance of time and space are necessary to maintain the global invariance of the "Interval", causality, and velocity c . Related to these effects we note the fundamental quenching of an electric field by magnetic induction in the free electromagnetic wave, a balancing or compensation which results in the electrically neutral photon (a quantum unit of light), the field vector of the electromagnetic force.

At the next level of material expression, we see the atomic combination of the electron and proton, which also achieves electrical neutrality thanks to the magnetic field of the electron, despite the electron's orbital motion around the comparatively stationary proton. The universe is constructed in such a way (through global-local gauge symmetries and their transformations via the field vectors) that invariant constants derived from the spatial and absolute realm of light can nevertheless subsist in the relative, temporal realm of matter, although in an altered (but also invariant) form - charge. In their completely global or universal symmetric form, charges are directly related to light's symmetry through the virtual matter-antimatter particle pairs that light's energy constantly creates and annihilates throughout the spatial "vacuum". Similarly, material local charges are constantly in communication and equilibrium with their global counterparts through the swarms of virtual particles that surround them. Thus the separation between global and local energy forms, charges, and symmetry states is more apparent than real: the ideal forms remain with us, and we experience them directly through light and thought.

Links

Unified Field Theory

[Section I: Introduction to Unification](#)

[Symmetry Principles of the Unified Field Theory \(a "Theory of Everything"\) - Part I](#)

[Symmetry Principles of the Unified Field Theory \(a "Theory of Everything"\) - Part 2](#)

[Symmetry Principles of the Unified Field Theory \(a "Theory of Everything"\) - Part 3 \(summary\)](#)

[Principles of the Unified Field Theory: A Tetrahedral Model](#)

[\(Postscript and Commentary on paper above\)](#)

[Synopsis of the Unification Theory: The System of Spacetime](#)

[Synopsis of the Unification Theory: The System of Matter](#)

[Light and Matter: A Synopsis](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part I\)](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part II\)](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model":Postscript](#)

[Global-Local Gauge Symmetries: Material Effects of Local Gauge Symmetries \(part IV\)](#)

[Global-Local Gauge Symmetries and the "Tetrahedron Model" \(part V\)](#)

[The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison](#)

[Synopsis of the "Tetrahedron Model" of the Unified Field Theory](#)

[The Tetrahedron Model in the Context of a Complete Conservation Cycle \(text\)](#)

Gravitation

[Section II: Introduction to Gravitation](#)

[A Description of Gravitation](#)

[Global-Local Gauge Symmetries in Gravitation](#)
[The Double Conservation Role of Gravitation: Entropy vs Symmetry](#)
[12 Summary Points Concerning Gravitation](#)
[Extending Einstein's "Equivalence Principle"](#)
[The Conversion of Space to Time](#)
["Dark Energy": Does Light Produce a Gravitational field?](#)

Entropy

[Section VII: Introduction to Entropy](#)
[Entropy, Gravitation, and Thermodynamics](#)
[Spatial vs Temporal Entropy](#)
[Currents of Symmetry and Entropy](#)
[The Time Train](#)
[The Halflife of Proton Decay and the 'Heat Death' of the Cosmos](#)

Weak Force, Intermediate Vector Bosons ("IVBs")

[Section IV: Introduction to the Weak Force](#)
[The "W" Intermediate Vector Boson and the Weak Force Mechanism](#) (pdf file)
[The "W" IVB and the Weak Force Mechanism](#) (html file)
[Global-Local Gauge Symmetries of the Weak Force](#)
[The Weak Force: Identity or Number Charge](#)
[The Weak Force "W" Particle as the Bridge Between Symmetric \(2-D\) and Asymmetric \(4-D\) Reality](#)
[The Strong and Weak Short-Range Particle Forces](#)
[Section XVI: Introduction to the Higgs Boson Papers](#)
[The "Higgs" Boson and the Spacetime Metric](#)
[The "Higgs" Boson and the Weak Force IVBs: Part I](#)
[The "Higgs" Boson and the Weak Force IVBs: Parts II, III, IV](#)
["Dark Matter" and the Weak Force](#)

References:

- Brewer, J. W. and M. K. Smith, eds. *Emmy Noether: A Tribute to her Life and Work*. 1981. M. Dekker, New York.
- Pierre Teilhard de Chardin: *The Phenomenon of Man*. 1959. Harper and Row, New York.
- Frank Close: *Lucifer's Legacy*. 2000. Oxford Univ Press.
- Books by my late father Prof. John Curtis Gowan
- ["Trance, Art, Creativity" An Investigation of the Numinous Element and the Metaphysical Realm. A Book by Prof. John C. Gowan, Sr.](#)
- ["Operations of Increasing Order" Further Investigations of the Numinous Element and the Metaphysical Realm. A Book by Prof. John C. Gowan, Sr.](#)
- ["Development of the Psychedelic Individual". A Book by Prof. John C. Gowan, Sr.](#)
- ["Development of the Creative Individual". A Book by Prof. John C. Gowan, Sr.](#)
- Leon Lederman with Dick Teresi: *The God Particle*. 2006. Mariner Books.
- Leon Lederman and Christopher Hill: *Symmetry*. 2008. Prometheus Books.
- J. E. Lovelock. *Gaia. A New Look at Life on Earth*. 1979. Oxford University Press.
- Neuenschwander, Dwight E. *Emmy Noether's Wonderful Theorem*. 2011. The Johns Hopkins University Press.
- Robert Oerter: *The Theory of Almost Everything*. 2006. Penguin (Plume).
- Pais, Abraham *Inward Bound: of Matter and Forces in the Physical World*. 1986. Oxford University Press, NY
- Robert Resnick: *Introduction to Special Relativity*. 1968. John Wiley and Sons, Inc.
- James S. Trefil: *The Moment of Creation* 1983. Collier, Macmillan.

Frank Wilczek: *The Lightness of Being*. 2008. Basic Books.