# Extending Einstein's Equivalence Principle: Symmetry Conservation

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John A. Gowan
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## Abstract

Einstein's "Equivalence Principle" asserts that a gravitational field cannot be distinguished from a suitably chosen accelerated reference frame - essentially because we cannot distinguish between the reciprocal cases of spacetime accelerating through us (gravity), or our own acceleration through spacetime (as in a rocket ship). Hence the equivalence between inertial and gravitational mass - classically recognized by Newton as the equivalence between inertial resistance and gravitational "weight", but not understood.

Co-movers with a gravitational field (in free fall or orbit) experience no "weight" - the field apparently vanishes. This seminal observation allowed Einstein to equate gravitational and inertial fields in his General Theory of Relativity. Because there is another way to "vanish" a gravitational field, the possibility of extending Einstein's "Equivalence Principle" beyond inertial force is raised. The conversion of bound to free energy (mass to light) in many spontaneous astrophysical processes, such as stars (partially) and black holes (completely), "vanishes" the gravitational field that had been associated with the converted mass. This suggests a heuristic conceptual pathway for the unification of forces through Noether's symmetry conservation theorem via the equivalence of all charges and forces (including gravity) as symmetry debts of light: *the charges of matter are the symmetry debts of light*.

In this view gravity is seen as arising from a "location" charge which records the symmetry debt carried by any immobile massive particle, the debt arising from the loss of the non-local distributional symmetry of the light which created the particle or otherwise contributed to its mass. The active principle of this "location" charge is time, whose intrinsic motion also produces the historical entropy drive of matter. *A gravitational field*

*is the spatial consequence of the intrinsic motion of time*. (See: "Symmetry Principles of the Unified Field Theory: Part I"; "Gravity, Entropy, and Thermodynamics"; "The Double Conservation Role of Gravitation: Entropy vs Symmetry"; "The Conversion of Space to Time".)

**Overview**

Einstein's "Equivalence Principle" asserts the equivalence between inertial and gravitational forces of acceleration. It rests upon the fact that we cannot distinguish between the inertial forces ("g" forces) experienced (for example) in a rocket ship accelerating through space, and the gravitational forces experienced (for example) on the surface of the Earth, which latter are actually due to spacetime accelerating through us. From this reciprocity of forces Einstein was able to deduce the fact that gravity bends light (because gravity "bends" (accelerates) spacetime).

Our extension (in two respects) of this famous principle begins with the recognition that a gravitational force, as we experience it on Earth's surface ("weight"), is actually caused by spacetime accelerating through us on its way to the center of the Earth. We feel the force only because we are unable to follow the natural flow of spacetime which tries to carry us with it. In "free fall" or orbit we are co-movers with the spatial flow, and feel no force at all, as we offer no resistance to its inertial urgings.

If we follow this spatial flow to the center of the Earth (or to each and every atom thereof), we find it annihilates itself with opposing flows coming from every direction in a symmetrically imploding spherical collapse: +x annihilates -x, +y annihilates -y, and +z annihilates -z, so that at the center of the field gravity actually vanishes, quenching itself. But Einstein has taught us that space is not purely space, it is spacetime, so when the spatial dimensions annihilate one another at the center of gravity, time remains as a metrically equivalent residue of the annihilated space (being one-way, there is +t but no -t). In effect, gravity transforms space to its metrically equivalent temporal component, converting the implicit time in spacetime to purely explicit time in the historical domain. (See: "The Conversion of Space to Time)".

Because time has intrinsic motion, in fact an intrinsic motion which is functionally and metrically equivalent to light's intrinsic motion (both being entropy drives of effectively "infinite" velocity within their respective conservation domains - space and history), as soon as time becomes explicit, it marches off into history, which is at right angles to all three dimensions of the spatial domain.

Because space and time are connected, the intrinsic motion of time into history pulls space after it, but space cannot follow since the historical domain is at right angles to all three spatial dimensions simultaneously, and therefore space self-annihilates at the point-like entrance of the one-way time line into history. This annihilation is continuous, because the (entropic) march of time is continuous, and the annihilation of space only creates more time, so the entire process is cyclic, self-feeding, and endless. The spherical collapse of space is due to the symmetrical connection between time and the three spatial dimensions. The accelerated flow of space is due to the constant application of a force - the entropic, "intrinsic" march of time.

So we arrive at our (first) extension of the Equivalence Principle: *a gravitational field is the spatial consequence of the intrinsic motion of time*. Gravitational energy is temporal energy, and both are

entropy-energy, borrowed from the expansive entropy-energy of light which drives the spatial expansion and cooling of the Cosmos: the spatial Universe decelerates in compensation for the expansion of the historical (causal) Cosmos. We will call this first extension the "entropic" extension of the equivalence principle, since it addresses gravity in its low-energy, entropic conservation role.

Just as Einstein's Equivalence Principle led him to an understanding of (one of) the actions of gravitation (the bending of light), so our (first) extension of his principle leads us to an understanding of (one of) the conservation roles of gravity - the creation of matter's (bound energy's) primordial entropy drive, the intrinsic motion of time, by the gravitational annihilation of space and the extraction of a metrically equivalent temporal residue. Time marches on to create history, the temporal analog of space, and the entropic conservation domain of matter's causal information field or "matrix". Energy conservation requires time to be one-way because matter is causally entrained.

The equivalence in this first extension is between gravity and time, or between gravitational entropy-energy and temporal entropy-energy. It takes energy to create the asymmetric time dimension from the symmetric spatial dimensions, and that energy is the gravitational energy of any given mass (-Gm). The energy of Earth's gravitational field, for example, is the energy (entropy-energy) required to create Earth's time dimension. This energy is due to the gravitational "location" charge carried by all massive particles (-Gm), and is ultimately derived (subtracted) from the cosmological expansion of spacetime, which decelerates accordingly. Conceptually, space contains time in an implicit condition, and it is just that *implicit* time component which motivates the intrinsic motion of light and the entropic expansion of space. This same temporal component is exposed in its *explicit* condition by the gravitational annihilation of space, whereupon it proceeds to motivate the entropic expansion of history, inducing the endless self-feeding cycle sketched above.

Summarizing in the case of free electromagnetic energy: energy conservation, entropy, and symmetry conservation work together to cause the "intrinsic" all-way motion of light which drives the expansion and cooling of space, and suppresses the asymmetric time dimension. Summarizing in the case of bound electromagnetic energy: energy conservation, entropy, causality, and gravity work together to create the intrinsic one-way motion of time and the expansion and aging of history. It is gravity which converts either entropy drive into the other by converting space to time (entropic phase) or mass to light (symmetry phase). Gravity binds the compound conservation domain of spacetime together because in either case it works with metrically equivalent entropy drives or energy states.

The primordial conservation role of gravity is to provide negative energy sufficient to exactly balance the positive energy of the "Creation Event", so the universe can be born from a state of zero net energy as well as zero net charge (the latter due to the equal admixture of matter with antimatter). All subsequent conservation roles of gravity are secondary to and derived from this original creation-role.

Following on from its primary role of providing negative energy during the "Big Bang", gravity plays two further major conservation roles in the evolving universe: 1) The conversion of light's spatial entropy drive (the intrinsic motion of light), into bound energy's historical entropy drive (the intrinsic motion of time); 2) the conservation of light's "non-local" distributional symmetry, via gravity's "location" charge, as required by Noether's Theorem: *the charges of matter are the symmetry debts of light*. This debt, like all symmetry debts held as conserved charges, is indefinitely deferred through time to be paid by such processes as the (partial) gravitational conversion of bound to free energy in

stars, supernovas, and quasars, and the (complete) conversion of mass to light by Hawking's "quantum radiance" of black holes. Such processes simultaneously pay the temporal entropy debt, and indeed any energy, entropy, or symmetry debt that might be held by the charge, mass, and generally asymmetric energy state of matter.

The double conservation role of gravity is due to the double regulating role played by the electromagnetic constant "c": the velocity of light gauges both the entropy drive of light (light's intrinsic motion), and light's non-local distributional symmetry (vanishing time and the x (distance) spatial dimension). Gravity conserves both roles by default if - in obedience to Noether's Theorem - it conserves either one. (Because gravity creates time, its conservation roles also embrace energy conservation and causality.) (See: "Synopsis of the 'Tetrahedron Model'".)

Whereas Einstein's original equivalence principle vanishes our perception of gravitational "weight" (in free fall or orbit), the extension of this principle to gravity's symmetry conservation role actually vanishes the force itself, since in the conversion of mass to light, gravity itself is annihilated: light freely moving in vacuum produces no gravitational field. We will call this second extension of Einstein's equivalence principle the "symmetric" extension, since it addresses gravity's higher-energy symmetry conservation role, in obedience to "Noether's Theorem".

The equivalence in this second extension is between gravity and the other charges of matter which all originate as symmetry debts of light (matter itself originates in light, being one-half of a particle-antiparticle pair). (The original or "great asymmetry", from which all others derive, is due to the weak force, which produced our "matter-only" Cosmos during the "Big Bang". The "missing antimatter" symmetry debt is carried by electric charge.) Time is the active and entropic principle of gravity's "location" charge. Charges produce forces which act to return the asymmetric material system to its original symmetric state, free electromagnetic energy (light). Gravity pays the entropy-"interest" on the symmetry debt of matter, creating time, history, and a compound spacetime metric (historic spacetime with temporal entropy drive) within which temporally deferred charge conservation can exist, function, and have a causal significance. Within spacetime, the conservation requirements of both free and bound forms of electromagnetic energy can be, must be, and are simultaneously satisfied.

While in Einstein's original principle we find the equivalence of gravitational and inertial forces, and finally (through 4-dimensional tensor geometry) their conceptual unity as "curvatures" or "warpages" (accelerations) of spacetime, in the principle as extended here we find the equivalence of gravity and time, and finally (through Noether's Theorem) their conceptual unity as symmetry and entropy debts of light - a unity which through symmetry conservation embraces all the charges and forces of physics. When the force completely vanishes, then we know the symmetry debt which caused it has been fully repaid.

(See: "Symmetry Principles of the Unified Field Theory"; "A Description of Gravitation"; "Entropy, Gravitation, and Thermodynamics"; "The Double Conservation Role of Gravity"; "Proton Decay and the 'Heat Death' of the Cosmos"; "The Conversion of Space to Time"; "Spatial vs Temporal Entropy".)

**Noether's Theorem and the Conservation of Symmetry**

Extending Einstein's "Equivalence Principle" depends upon recognizing the dual conservation role of

gravitation with respect to 1) light's entropy drive (intrinsic motion); 2) light's "non-local" metric and distributional symmetry. Beyond primordial energy conservation during the "Big Bang" (balancing the positive energy of the "Creation Event"), gravity's "primary" conservation role in today's universe is the conservation of light's entropy drive (the intrinsic motion of light), accomplished by the gravitational conversion of space to time. This is one of the roles reflected in Einstein's gravitational field equations as the "warpage", "curvature", or "acceleration" of the spacetime metric. The "curvature" of the otherwise symmetric spatial metric is due to the presence of bound energy (mass), gravity, and asymmetric time, specifically time's intrinsic, one-way motion. Time is created by the gravitational annihilation of space, exposing a metrically equivalent temporal residue. The primordial, spatial entropy drive of free energy (the intrinsic motion of light), is gravitationally converted (conserved) to the primordial, historical entropy drive of bound energy (the intrinsic motion of time). This primary or entropic conservation role of gravity is accomplished on every scale of bound energy and gravitational action, from electrons to supermassive black holes. (Because of the role of time in the energetic accounts of massive objects in relative motion, gravity's entropy and energy conservation roles are thoroughly intertwined.) (See: "Gravity, Entropy, and Thermodynamics" for an extended discussion of gravity's entropy-conservation role. Below I focus on gravity's symmetry-conservation role.)

The extended equivalence principle includes gravity's "secondary" conservation role, the conservation of light's metric and "non-local" distributional symmetry, accomplished by the gravitational conversion of bound to free energy, in obedience to "Noether's Theorem". This role is played out only on sufficiently large and energetic scales, such as stars, supernovas, quasars, etc., and goes to completion through Hawking's "quantum radiance" of black holes. Gravity's symmetry conservation role essentially reverses the effect of its entropy conservation role. The two roles act upon matter simultaneously in stars, producing a "steady state" of tension between gravitational collapse and radiative expansion. This secondary, symmetry conserving role of gravitation was not emphasized (or recognized?) by Einstein, but is the consequence of a famous theorem formulated by his contemporary, Emmy Noether, in 1918. (See: The Double Conservation Role of Gravitation: Entropy vs Symmetry.)

The two conservation roles of gravity are consequences of two "gauge" roles of the electromagnetic constant, "c" (the "velocity of light"). "Velocity c" gauges the primordial entropy drive of free energy (the intrinsic motion of light), which causes the creation, expansion, and cooling of space. "Velocity c" also gauges the "non-local" distributional symmetry of light's energy, including the symmetry of the metric of spacetime, in which light has no time dimension and lacks one spatial dimension (in the direction of propagation). Because both effects depend upon light's "intrinsic motion", as gauged by "velocity c", both are conserved together by gravity as it acts (in obedience to Noether's Theorem) to conserve either the entropic or symmetric characteristics of light's intrinsic motion. (See: A Description of Gravitation.)

"Noether's Theorem" implies that "*the charges of matter are the symmetry debts of light*", and requires that the symmetries of light be conserved in any transformation of light's symmetric energy state, especially such a drastic transformation as the conversion of light's free energy to the bound form of matter - or even the capture of a photon by the electron shell of an atom. Gravity is the force which conserves both light's spatial entropy drive (intrinsic motion) and "non-local" symmetric energy state, the former (immediately) by converting light's intrinsic motion to time's intrinsic motion, and the

latter (eventually) by converting bound to free energy, as in the stars, supernovas, quasars, and (ultimately and completely) Hawking's "quantum radiance" of black holes. The importance of extending Einstein's "Equivalence Principle" into the symmetry conservation domain of "Noether's Theorem" is that it allows us to recognize gravitation as a symmetry debt of light *like the other charges of matter,* and proceed with a (conceptual) plan of force unification upon this fundamental basis of conservation law. (See: "Symmetry Principles of the Unified Field Theory".)

Einstein's original "Equivalence Principle" unified gravitation, spacetime, and the inertial symmetry-keeping and energy-conserving forces of the metric (the "g" forces of accelerated motion). Noether's Theorem shows us the way to extend this unification to all the charges of matter, that is, to particles, charges, and their symmetry-keeping forces - under the mantel of symmetry and charge conservation. Like the other charges and their forces, gravity results from a charge which carries a symmetry debt of light. This charge is "location", whose active principle is time, representing the symmetry debt of the "non-local" distribution of light's energy, a symmetry broken by the conversion of freely moving light into immobile, massive forms of bound energy (matter). Unique among the charges, the active principle of gravity's "location" charge is time, a charge with intrinsic, entropic, dimensional motion. It is the peculiar nature of the time charge that makes gravity universal, weak, relentless, and irresistible.

## Einstein's "Equivalence Principle"

"Big G" is the universal gravitational constant, familiar to us through Newton's famous formula for the gravitational force acting between two bodies: F = GMm/rr, where Mm is the mass of the respective bodies, and r is the distance between their centers. "G" is Newton's invariant and universal constant or "gauge" of gravitational force.

"Little g" is the local intensity of the gravitational field; it measures the force or "weight" we feel standing on Earth's surface. "Little g" (for example) is much less on the surface of the Moon, but "big G" is the same everywhere. "Little g" is also equivalent to the inertial "g" forces of acceleration experienced in sudden starts, stops, and sharp turns (Einstein's "Principle of Equivalence" of gravitational and accelerated reference frames). The equivalence holds because as we stand on the surface of the Earth, space accelerates through us toward Earth's center, while in the reciprocal situation (through the appropriate application of energy), we accelerate through space (in a "rocket ship", for example). "g" forces vanish in "free fall" (or orbit) because we become co-movers with the field. Similarly, acceleration forces vanish when we "turn off the engines" and drift freely in space with the metric's inertial field. An earlier version of the equivalence principle, attributed to Newton, noted only the unexplained correspondence between inertial "mass" and gravitational "weight" (see below). It is readily seen that Einstein's equivalence principle (the acceleration or "curvature" of spacetime) includes and explains its predecessor.

## The Three Levels of the Equivalence Principle

A) (Newton) Mechanical - The equivalence of inertial "mass" and gravitational "weight". "Mass" vanishes. All objects (regardless of mass) fall with the same acceleration.

> 1) Inertial mass and gravitational weight are equivalent, so inertial mass can be measured by weighing objects against a standard in a gravitational field. The cause of this

equivalence is unknown. The equivalence is invoked to explain why all things fall with the same acceleration in a gravitational field. (The inertial resistance to motion offered by any object's "mass" exactly counterbalances the attractive force of gravitation due to that object's "weight" - rendering all differences in weight irrelevant to the action of gravity.)

B) (Einstein) Geometric - The equivalence of the forces of gravitation and the "inertial" forces of acceleration. "Weight" vanishes. Falling objects are co-movers with moving spacetime.

1) The forces of gravitation and the inertial forces of acceleration are equivalent, and "free fall", orbital motion, and "coasting" cause both to vanish: we deduce from this:
2) the force of gravity is actually the convergent, accelerated motion of spacetime, explaining the equivalence of gravitational "weight" and inertial "mass" (cannot distinguish between the reciprocal effects of spacetime accelerating through us ("weight"), or we accelerating through spacetime ("mass"));
3) Free fall, orbit, (or "coasting") is the condition of co-moving with the metric field, whether accelerated or not;
4) Since all falling, orbiting, (or "coasting") objects are co-movers with the metric field of spacetime, they are also co-movers with each other (or at rest relative to each other), explaining the fact that all objects fall with the same acceleration in a gravitational field. However, the reason *why* gravity accelerates spacetime (what is the conservation role of this force? - or equivalently: what natural law requires the existence of gravity?) remains unknown.

C) (Noether) Symmetric/Entropic - The equivalence of gravity and time. Gravity vanishes. In the conversion of bound to free energy (as in stars), gravity vanishes since light has no time dimension and produces no gravitational field when moving freely in vacuum.

1) A gravitational field is the spatial consequence of the intrinsic motion of time. The charges of matter are the symmetry debts of light (Noether's Theorem). Like the other forces, gravity is produced by a charge ("location" charge); the active principle of "location" charge is time.
2) "Location" charge arises in response to the breaking of light's "non-local" metric and distributional symmetry: in any transformation of free to bound energy, the symmetry as well as the raw energy of light must be conserved (Noether's Theorem). Charge conservation, gravitation, and inertial force are all aspects of symmetry conservation (in particles and the spacetime metric). Time is an entropic charge, a charge with intrinsic dimensional motion - conceptually connecting gravity with the other charges and forces, and relativity with quantum mechanics.
3) Free and bound energy are energetically equivalent (E = mcc): during the "Big Bang", matter is created from the interaction of high-energy light with the structure of the spacetime metric and the co-operative effort of all four forces of physics. Conversely, light is created from mass/matter in stars and via Hawking's "quantum radiance" in black holes. Matter is an asymmetric, bound (massive) form of light's energy.
4) The charges of matter are the symmetry/entropy debts of the light (free energy) which created matter. Converting matter back to light pays all symmetry/entropy debts, *completely vanishing the gravitational force*.

5) Noether's theorem - the conservation of light's symmetry - is exampled by the forces of charge conservation, inertia, and the primordial form of light's spatial entropy drive (the intrinsic dimensional motion of light as gauged by "velocity c", vanishing time and distance, suppressing virtual particles, maintaining metric and inertial symmetry). *The charges of matter are the symmetry debts of light*. The entropy drive (intrinsic dimensional motion) and "non-local" metric and distributional symmetry of light are linked, both attributes gauged by "velocity c", and therefore (by default) both are conserved together in obedience to Noether's symmetry conservation theorem. Charges produce forces which pay the symmetry/entropy debts they hold by returning the asymmetric bound energy system to its original symmetric free energy state (light). Time is an entropy and symmetry debt (charge) of light's (broken) non-local symmetric energy state which produces gravitation as a restorative or conservation force. *A gravitational field is the spatial consequence of the intrinsic motion of time*. (See: "The Conversion of Space to Time".) All forms of energy originate as, and eventually return to, light. (See: "The Tetrahedron Model".)

The single, universal purpose of all symmetry debts is deduced from the fact that all charges produce forces which act to return the material system to its original symmetric state by converting bound to free energy - not only through chemical reactions, matter-antimatter annihilations, particle and proton decay, but also through gravitational processes exampled by our Sun and the stars, supernovas, quasars, and the ultimate, complete conversion of bound to free energy in Hawking's "quantum radiance" of black holes.

**Entropy vs Symmetry Debts of Light and Matter**

Since both the spatial entropy drive and the "non-local" metric and distributional symmetry of light are regulated, scaled, or "gauged" by "velocity c" (the "intrinsic motion" of light), when one is conserved, the other is also. Entropy is a corollary of energy conservation, and when energy is transformed and conserved, some form of entropy must be transformed and conserved as well. When light transforms to matter, that new bound state will require a new entropy drive appropriate to that state - as provided by the quantum mechanical and gravitational transformation of space and free energy's (light's) spatial entropy drive to time and bound energy's (matter's) historical entropy drive. Time's intrinsic motion creates a new conservation domain for matter's causal information matrix - history (historic spacetime). Because velocity c is also the gauge of metric symmetry, *we can bring the gravitational conversion of space to time (gravity's entropy conservation role) under the symmetry conservation mantel of Noether's theorem*. (See: "Spatial vs Temporal Entropy".)

The enlarged framework of the extended equivalence principle allows gravity to join the other forces as a *symmetry/entropy debt of free energy* (by Noether's theorem, all charges of matter are the symmetry debts of light). The "entropic charge" of time, the active principle of gravity's "location" charge, contains in itself the essential joining of the dimensional aspects of General Relativity with the charge aspects of Quantum Mechanics: 1) the intrinsic dimensional motion of time, acting as matter's entropy drive, producing by its own motion (into history) the collapsing, accelerated spatial flow we commonly recognize as a gravitational field; 2) time as the "locating" charge of the four dimensions, the symmetry debt of light's (broken) "non-local" distribution, providing mass with a specifiable location in spacetime (including quantity and density), a nonzero "Interval" resulting (eventually) in

the gravitational conversion of mass to light (as in stars). Charges produce forces whose conservation purpose is to pay the symmetry debts they hold; payment of the temporal symmetry and entropy debt of mass drives the gravitational conversion of bound to free energy - in stars, supernovas, quasars, and finally and completely, in Hawking's "quantum radiance" of black holes. (See: "Symmetry Principles of the Unified Field Theory".) (Note that time is able to uniquely specify or "locate" the 4-dimensional coordinate position of mass because the entire universe begins as a single unit at "time zero" in the "Big Bang".)

The Bekenstein-Hawking theorem relates the surface area of the "event horizon" of a black hole to the entropy content of the hole. (See: Bekenstein, J. D. *Information in the Holographic Universe*. Scientific American, August 2003, pages 58-65.) Black holes are the physical demonstration of the gravitational conversion of space and the drive of spatial entropy to time and the drive of historical entropy. The "surface" of a black hole (the area of its "event horizon") is a time "surface" where time effectively stands still because time is being replaced by the intense local gravitational field (g = c) as fast as time moves away into the historic domain (swallowed, like everything else, by the black hole). Light's spatial metric collapses, overwhelmed by matter's temporal/gravitational metric. In an extreme example of "Lorentz Invariance" (the co-variance of space with time), as meter sticks shrink to nothing, clocks slow to a stop (seconds become infinitely long as meters become infinitely short).

While we can think of the ordinary rock as an asymmetric form of light's energy transformed to matter and brought to rest, we can likewise think of the event horizon or surface area of a black hole as an asymmetric form of light's entropy transformed to time and brought to rest. A black hole's "event horizon" delimits a "rock" formed from light's entropy. (See: "The 'Tetrahedron Model' vs the 'Standard Model' of Physics: A Comparison".)

**Hawking's "Quantum Radiance" of Black Holes**

When we extend Einstein's "Equivalence Principle" to include gravity's symmetry conservation role, it is through the "location" charge of gravity, whose active principle is time. The "location" charge allows us to treat gravity like any other charge of matter, as a symmetry debt of light. Because time is an entropic "charge" of matter (a charge with intrinsic dimensional motion), the extension of the Equivalence Principle from inertia to charge is natural. Time is the bridge between the charges of matter and the intrinsic dimensional motions of entropy's primordial forms (the intrinsic motions of light, time, and gravity). Time is the entropic charge of gravity and bound energy. Time's intrinsic motion produces both the primordial, historical entropy drive of matter and eventually, in sufficiently large bound energy concentrations (such as stars), a gravitational force strong enough to begin the symmetry conservation role of gravity, converting bound energy back to light.

Do we ever see this charge aspect of time, "location charge", or gravity, explicitly expressed in particle form (as a "graviton"), as the union of gravity with the other charges and forces suggests we might? This is indeed the case in Hawking's "quantum radiance" of black holes, where extreme gravitational tidal warpage (or differential acceleration) of spacetime produces particle-antiparticle pairs directly out of the spacetime metric or "vacuum". The "negative energy" of the black hole's gravitational field is used to produce antimatter and so annihilate the "positive energy" of the black hole's mass. In this case "gravitons" take the form of ordinary particle-antiparticle pairs.

"Quantum radiance" is the ultimate expression of the symmetry conservation role of gravity and the extended equivalence principle through particle charge, in which we see not only the vanishing of the gravitational force, but gravity acting like any other charge of matter - the equivalence of gravity and charge. The extended equivalence principle (we might call it "Noether's Equivalence Principle") thus leads us to the union of gravity and quantum mechanics, the unity of forces, and the unity of particles, light, gravity and spacetime, via Hawking's "quantum radiance" - as Einstein's original Equivalence Principle led us to the union of gravity with spacetime via Newton's inertial forces of acceleration. (For a discussion of gravity's weakness, see: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".)

**The Extended Equivalence Principle Applied to the Four Physical Forces**

Whereas in the other forces, analogs of the gravitational "equivalence principle" are known (the vanishing of magnetic forces for co-movers in the electromagnetic force, the vanishing of the gluon field and color charge due to "asymptotic freedom" in the strong force"), the corresponding analog of the equivalence principle in the weak force is not obvious.

The suppression (vanishing) of weak force beta decay occurs in compound atomic nuclei and on an astronomical scale in the phenomenon of the neutron star. These grossly differing mass scales are the consequence of the binding action of the short-range nuclear strong force (meson/gluon exchange), as contrasted with the binding action of the long-range spacetime gravitational force (massless graviton exchange). In both cases the beta decay of the neutron is suppressed because the negative energy of the binding force, whether nuclear or gravitational, has reduced the effective positive energy of the neutron below the threshold it requires to produce an electron and an electron antineutrino, and so achieve beta decay.

There is, however, another and more interesting way to suppress the activity of the weak force (ignoring the obvious case of matter-antimatter annihilation reactions), which is to simply turn up the heat - or equivalently, turn back the clock to the primordial energy densities of the "Big Bang", when particles were first being created and transformed by the weak force. These primordial environmental conditions are actually reproduced by the very massive IVBs (and Higgs bosons) of the weak force, in three energy levels or "families". There are three high-energy plateaus or symmetric energy states during the early "Big Bang", when the forces were joined and the distinctions between the various elementary particles were erased. During these eras of force unification, the weak force as we know it was suppressed, simply because the various particles merged their identities with one another and so did not require an IVB mechanism to accomplish transformations - any transformations were accomplished simply during the normal course of events, because the particles' identities were already merged into a higher "taxonomic" category (as from "species" to "genus") or symmetry group. We can think of the IVBs as "time machines", taking us back to the early history of the Cosmos, to a sort of primordial "golden age" of symmetry and harmony, as their great mass recreates the several force unification eras of the first moments of the "Big Bang". (See: "The Symmetry Groups of Light".)

I therefore suggest that in the weak force the analog of the "Equivalence Principle" is expressed as the unified force symmetric energy states created by the mass of the IVBs (the electroweak unified force energy state in the case of the "W" IVB family), in which the individual "number" charges ("identity" charges) of the lepton species, and the individual "flavor" charges of the quark species, become

indistinguishable (vanish), except at the "generic" level of "lepton" vs "quark". Because of this internal symmetry state within the lepton and quark "genera", transformations from one lepton "identity" charge to another, or from one quark "flavor" charge to another, are accomplished simply as a matter of course, without the mediation of an IVB. At the electroweak energy level, single leptons and mesons are produced, and baryons are transformed, via the "W" IVB, as the generic symmetry state spontaneously breaks/devolves to a particular quark or lepton species.

At the even higher energy level of the "X" IVB, the GUT unified force symmetric energy state (in which the strong and electroweak forces are joined), the "generic" distinction between leptons vs hadrons vanishes and a unification among both genera at the "family" level of *fermions* is realized (to borrow some categorical terms from the biological taxonomic hierarchy), in which quarks and leptons can freely transform one into another. Leptoquark decay at this energy level, via the "X" IVBs and leptoquark neutrinos, produces single heavy baryons ("hyperons"). This is the level from which our "matter only" universe devolved, via the asymmetric action of the weak force. (See: "The Origin of Matter and Information".)

The final unified force symmetric energy state (all forces joined) is realized at the TOE or Planck energy level (the "Y" IVB family), in which the family distinction between the fermions and bosons vanishes, and particles are created (in particle-antiparticle pairs) from the interaction of light, the spacetime metric, and the combined action of all four forces of physics, including gravity. These first particles are the primordial elementary leptonic particles (Gamow's "ylem") which are internally fractured into 3 parts (the nascent quarks), creating the "leptoquark era". As the "Big Bang" expands and cools, bosons, gravity, and spacetime separate from fermionic particles. Single, electrically neutral leptoquarks are produced by the weak force decays mediated by the "Y" IVBs of the TOE energy level, creating the next lower "Leptoquark" era, in which the matter and single heavy baryons of our universe were produced. (See: "Table of the Higgs Cascade".)

A basic role of the weak force is to provide the quantum-mechanical foundation for particle "identity" and bound energy, establishing a mass scale for specific particles (nodes of the "leptonic spectrum"), creating a structural framework for energy conservation during the transformation of free energy into bound energy. It is the weak force which actually gauges and scales (with the Higgs boson and the IVBs) and otherwise regulates (with "identity" charges and neutrinos) the conversion of the free energy of light into the bound energy of matter. In the weak force, the analog of "free fall", or the vanishing of forces, is therefore the unified force symmetric energy states created by the mass of the IVBs, in which the distinctions between particle species, genera, and families, and finally the forces themselves, simply vanish. (See: "The Higgs Boson and the Weak Force IVBs".) This follows the general rule that the "equivalence principle", as seen in the vanishing of any particular force, is a phenomenon associated with the "local gauge symmetry current" of that force. (See: "Global vs Local Gauge Symmetry Currents and the 'Tetrahedron Model'".)

**Summary**

When forces vanish, we see what their conservation role has been - we can answer the question: what do we have to do to make the force go away? This is the basis of Einstein's "Equivalence Principle". Free fall or orbit makes the gravitational force "vanish" in that we no longer feel our "weight" - we are no longer aware of the metric or inertial asymmetry caused by the action of the field. But this is only a

partial vanishing, analogous to the vanishing of a magnetic field by a co-moving observer. The true vanishing of magnetic fields and electric charges is accomplished by matter-antimatter annihilations, and there is also an analog of this process for gravitation ("quantum radiance") and indeed, for the strong and weak forces as well ("proton decay" - "asymptotic freedom").

The most complete expression of the extended gravitational "Equivalence Principle" is due to symmetry conservation as required by "Noether's Theorem", in which the gravitational force actually vanishes when matter-mass is converted to light (radiation) in stars and via Hawking's "quantum radiance" in black holes. In the case of "quantum radiance", the entire mass of the black hole is (eventually) gravitationally converted to light, completely annihilating its gravitational field, since light (freely moving in vacuum at velocity c) produces no gravitational field. (See: "Dark Energy: Does Light Produce a Gravitational Field?") Hawking's "quantum radiance" tells us that the ultimate conservation role of gravitation is symmetry conservation - returning asymmetric mass-matter to its original symmetric form, light - for only in the fulfillment of this conservation role does the gravitational force actually completely vanish. (See: "The Double Conservation Role of Gravitation".) The same holds for the other forces, as they all vanish when their symmetry debts are fully repaid (antimatter annihilation, particle and proton decay). *The charges of matter are the symmetry debts of light*.

From Einstein's "Equivalence Principle" we learn that gravity is equivalent to the accelerated motion of spacetime. Later we deduce the conservation rationale for this anomalous inertial asymmetry - that space is being gravitationally annihilated to create matter's time dimension. Later still, we recognize the symmetry conservation role of gravitation, in accord with "Noether's Theorem", as seen in the Sun, stars, related astrophysical phenomena, and (finally and completely) Hawking's "quantum radiance" of black holes.

There is an "Equivalence Principle" for each of the four forces, as suggested above - and usually in two forms - one a low-energy "maintenance" form in which the force simply obeys charge conservation and protects charge invariance, the other a high-energy symmetry conservation form in which the force annihilates the charge (usually by means of antimatter), returning the material system to light, with the force itself vanishing as a consequence .

The "equivalence" in this extended version of Einstein's "Equivalence Principle" is in the sense of the vanishing of the force, actually and completely in the extended version, rather than perceptually and incompletely in the original version. Furthermore, the "equivalence" in the extended case is not limited to gravity, but encompasses all the other forces and charges as symmetry debts of light, in all cases vanishing as they convert matter back to its original and symmetric form, free radiation. Hence while in the original version of the Equivalence Principle we learn that gravitation is an acceleration or "warpage" of the spacetime metric, in the extended version we learn that gravity is, *in common with the other charges and forces,* a symmetry debt of light. "Noether's Theorem" and the extended Equivalence Principle thus become the conceptual basis for the unification of gravity with the other forces and charges of physics, another stepping-stone toward the fulfillment of Einstein's dream.

**Links:**

**Unified Field Theory**

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
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"
Global-Local Gauge Symmetries: Material Effects of Local Gauge Symmetries
The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison
The Symmetry Groups of Light

**Gravitation**

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A Description of Gravitation
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The Double Conservation Role of Gravitation: Entropy vs Symmetry
12 Summary Points Concerning Gravitation
About Gravity
A Spacetime Map of the Universe
The Conversion of Space to Time
"Dark Energy": Does Light Produce a Gravitational field?

**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/Strong Forces**

The Strong and Weak Short-Range Particle Forces
Section XVI: Introduction to the Higgs Boson
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
The Higgs Boson and the Evolutionary Eras of the Cosmos
The Particle Table
Section XVIII: The Strong Force: Two Expressions

**Gravity Diagrams**

A New Gravity Diagram
The Gravity Diagram

The Three Entropies: Intrinsic Motions of Gravity, Time, and Light

Nodes of the Gravitational Metric

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