Time and Entropy
(revised May, 2011)

John A. Gowan
home page

This paper is part of a set of four, listed below, examining various relationships between the four conservation principles of the Tetrahedron Model of Natural Law (these short papers are not intended to stand alone):

Abstract

The intrinsic motions of light and time are metric equivalents; they are the primordial entropy drives of free and bound energy, creating space and history. The dimensions are entropic conservation domains allowing the simultaneous use, transformation, and conservation of free and bound electromagnetic energy. (See: "The Time Train"; see also: "The Paradox of the Traveling Twin".)

Entropy

History is an alternative entropic conservation domain which allows the Universe to retain "working energy" by storing energy in matter rather than light, and get old rather than large. Temporal aging and deterioration replaces spatial expansion and cooling - the expansion and cooling of space and the aging, decay, and dilution of history are analogous entropy drives (as gauged by "velocity c" and "velocity T"). As a surrogate dimension, the role of time is analogous to that of the alternative charge carriers of the "particle metric", the leptons. (Leptons replace the antiparticle partners of the quarks as substitute charge carriers, and thereby allow matter to manifest rather than simply annihilate with its usual antimatter charge carriers.) Furthermore, the role of entropy is analogous to the role of charge, in that entropy conservation allows the conversion of free energy to "work", and charge conservation allows the conversion of free energy to information (via atomic matter). Finally, just as matter is one-half of light's particle form (one-half of a particle-antiparticle pair), so one-way time is one-half of light's dimensional form (one-half of a two-way spatial dimension).

The primordial and first conservation role of gravity is to supply negative metric/entropic energy to balance the positive metric/entropic energy of the "Big Bang", allowing the universe to be born from an initial state of zero net energy and charge. The "zero charge" condition is achieved by balancing matter vs antimatter. All subsequent gravitational conservation roles seen in the evolving cosmos are derived from and secondary to this primary function, performed when gravity was united with the other forces during the first micro-moments of the "Creation Event". Chief among these latter-day conservation functions is the conversion of space to time (as on planet Earth) and vice versa (as in the stars).

Gravitation converts the primordial drive of positive spatial entropy (the intrinsic motion of light) into the primordial drive of positive historical entropy (the intrinsic motion of time), and vice versa. The magnitude

of "G" (the universal gravitational constant) is determined by the energetic difference between the drive of symmetric spatial entropy (S) (the intrinsic motion of light as gauged by "velocity c"), and the drive of asymmetric historical entropy (T) (the intrinsic motion of time as gauged by "velocity T"):

$$S - T = -G.$$

("Velocity T" is also gauged by "velocity c" as the duration required for light to travel a given distance.) Gravitational energy, creating time, is siphoned from the expansion of space, which slows in consequence. Thus it is the cosmic expansion of space, driven by the intrinsic motion of light, which ultimately funds the creation of matter's time dimension. Since entropy (the 2nd law of thermodynamics), creates dimensional conservation domains and prevents the "misuse and abuse" of energy, it is an essential adjunct to the 1st law of thermodynamics (the conservation of energy), and therefore must also be conserved (in transformations between free and bound energy), which is one of the several conservation roles of gravitation. The primordial entropy drives are simply built into the basic forms of free and bound electromagnetic energy as the "intrinsic" dimensional motions of light, time, and gravitation. The gravitational conversion of space and light's spatial entropy drive (S) to time and matter's historical entropy drive (T), can be represented symbolically by a "concept equation" as:

$$-Gm(S) = (T)m$$
$$-Gm(S) - (T)m = 0$$

Matter requires a time dimension to establish its historic "causal matrix", provide an entropy drive, and to balance its energy accounts, since matter's energy depends upon its relative velocity, which can vary from zero to (nearly) c. Light does not similarly need a time dimension because light is "non-local", acausal, and moves only with absolute (non-relative) velocity c. The energy of light varies with its frequency, not with its invariant velocity. Entropy is the "interest" paid to energy conservation for the use of energy; energy conservation allows the use of energy only through the entropy pathway.

Entropy allows energy to be used and transformed even while it is conserved. The accommodation is that energy may be used provided entropy increases while total energy remains constant. It is this increase in entropy which allows energy to be used at all, without violating the 1st law (energy conservation). Without actually using up or destroying energy in the process, energy is degraded (its capacity for work is reduced) but never destroyed; rather its entropy increases. The increase in entropy insures that the same energy cannot be used twice to produce the same net work, avoiding the perpetual motion machine and any violation of energy conservation (no complete machine cycle can create net energy). Thermal entropy is typically expressed as the production and loss of heat during work; "heat" (randomized molecular motion) is a universal entropic stage in energy transformations. (See: "Heat as the Currency of Work".) By the necessity for entropy, in principle no work can ever be accomplished with 100% efficiency; thermal entropy is often defined as the energy in an isolated system *which in principle cannot be transformed to work*. (See: "Spatial vs Temporal Entropy".)

The primordial or "pure" forms of entropy create dimensional conservation domains, space and history, via the intrinsic motions of light (gauged by "velocity c") and time (gauged by "velocity T"), while gravity's intrinsic motion (gauged by "velocity G") creates spacetime - a compound dimensional conservation domain in which both free and bound forms of electromagnetic energy can interact, be used and transformed, and yet find conservation through the mechanism of entropy. Gravity joins these two conservation domains of electromagnetic energy into a metrically equilibrated joint domain, spacetime. For reasons of energy conservation, bound energy (matter) requires an entropy drive - an intrinsic dimensional motion (time) - to create its spacetime conservation domain (historic spacetime), just as free energy (light) requires an entropy drive (intrinsic motion c), to create its spatial conservation domain. Unlike light, "local" matter requires time to establish its historic "causal matrix", which is an embedded requirement of energy

conservation in the case of bound energy. "Non-local" light, however, is both atemporal and acausal. The creation of matter's entropy drive (intrinsic motion T) from light's entropy drive (intrinsic motion c) is the role of gravity and its "location" charge, whose active principle is time itself. Massless light is spatial: non-local, atemporal, and acausal. Massive matter is historic: local, temporal, and causal. Light is connected by space; matter is connected by time; gravity connects all. (See: "A Rationale for Gravitation".)

Gravity and Temporal Entropy

Gravity is the entropy debt of light as well as the symmetry debt of light, the only one of the 4 forces arising from 2 kinds of debts and hence involving a doubly complex charge ("location" charge). This is because gravity's "location" charge represents the debt of "velocity c's" double gauge function with respect to light's intrinsic motion: "c" gauges both light's entropy drive and the non-local distributional and metric symmetry of light's energy. In conserving either function, gravity conserves the other by default. The active principle of the "location" charge is time, whose entropic character is its intrinsic dimensional motion, and whose asymmetric (one-way) character identifies the 4-dimensional locus of immobile bound energy, whose static mass breaks the non-local distributional symmetry of the light from which it was made. Both debts are satisfied (paid) simultaneously by the gravitational conversion of matter back to light (as in stars and Hawking's "quantum radiance" of black holes). (Gravity simply pays the "interest" on matter's symmetry debt when converting space to time (since neither the debt nor gravity are reduced thereby), but actually pays off the "principle" when mass is gravitationally converted to light (since gravity vanishes when mass vanishes).) (See: "The Double Conservation Role of Gravitation".)

Gravity is produced by every form of bound energy, but not by light moving freely in vacuum. "Non-local" energy which moves freely through space with intrinsic motion c (light) does not produce a gravitational field; bound energy which can be localized in space around a center of mass and therefore has a time dimension, will produce a gravitational field. Electromagnetic energy moves either with intrinsic (entropic) motion c or T; if with T, then it will also have intrinsic motion G, because G creates T; in fact, they induce each other. (See: "Entropy, Gravitation, and Thermodynamics".)

"Non-local" energy forms (with intrinsic motion c) cannot produce gravitational fields because they cannot provide a center for them: an uncentered gravitational field violates energy conservation. Einstein's "zero Interval" statement for light is a symmetry condition of "non-locality" for free energy and the absence of both time and gravitational fields. If light did produce a gravitational field, the Universe would never have escaped a black hole at its birth; furthermore, if all forms of energy produce gravity, then there is nothing to distinguish a conservation role for gravitation. So long as the scientific "establishment" continues to believe that free energy produces a gravitational field (for the insufficient reason that E = mcc), so long will it fail to achieve the unification of gravity with the other forces. (See: "Symmetry Principles of the Unified Field Theory".)

Only when a photon is absorbed by matter does it become bound energy with a positive "Interval", and only then does it begin to produce a gravitational field - converting its intrinsic spatial motion into intrinsic temporal motion, creating a historical entropy drive and a time dimension to service the energy conservation requirements of its new (bound and massive) inertial status. Although Einstein held that "gravity gravitates" (the "self energy" of a gravitational field produces more gravity and adds to the total gravitational force), light does not similarly produce a metric stress or warpage of the spacetime metric - instead, light creates the metric, and gauges, establishes, and maintains its symmetry. Hence the same arguement that suggests "gravity gravitates" cannot be used to suggest that "light gravitates". (See: "Does Light Produce a Gravitational Field?")

From the perspective of entropy, we gain a simplified view of gravitation. All forms of energy require entropy for reasons of energy conservation, including causality in the case of bound energy, as noted above.

The "infinite" velocities c and T are the actual "pure" or "primordial" mechanisms of entropy, permanently embedded in their energy forms (as we should expect), ensuring that radiant energy and opportunity escape in space and/or time with irretrievable velocity; these "infinite" velocities also seal and protect their domains against violations of causality and energy conservation via fast "space ships" or "time machines". Similarly, gravity seals the borders of its spacetime domain (against "wormholes") through the creation of the "event horizon" and "central singularity" of black holes. Spacetime is a wholly protected dimensional conservation domain for both free and bound forms of electromagnetic energy, created by the intrinsic and entropic motions of light, time, and gravity, as gauged by c, T, and G. In the black hole, the gravitational metric of time and matter completely replaces the electromagnetic metric of light and space, including its protective functions. Hawking's "quantum radiance" of black holes is the ultimate convergence of gravity's entropy and symmetry conservation roles, in obedience to Noether's Theorem. (See: "The Tetrahedron Diagram".)

With these principles in mind, we readily see that when free energy is converted into bound energy, an entropy drive will have to be created for that bound energy. This is (one of) the conservation roles of gravitation. When light or free energy is converted into matter or bound energy, three major attributes of light must be conserved: 1) light's raw energy, conserved as the mass and momentum of matter (1st law of thermodynamics); 2) light's spatial entropy drive (intrinsic motion c), conserved as matter's historic entropy drive (intrinsic motion T), accomplished by the gravitational conversion of space into time (2nd law of thermodynamics - establishing also matter's causal and historic relations); 3) light's symmetry, conserved as the charges and spin of matter and the inertial and gravitational forces of the metric (Noether's Theorem). *The charges of matter are the symmetry debts of light.* (See: "About Gravity".)

Time is implicit in free energy as "frequency", and is the actual driver of light's intrinsic motion: symmetric space ("wavelength") flees asymmetric time ("frequency"), which, however, is an embedded characteristic of light's own nature (frequency x wavelength = c). Time is the implicit, hidden, internal motivator of light's perpetual, self-motivated, "intrinsic" motion, velocity c. "Velocity c" is actually a symmetry condition of free energy, which, in obedience to Noether's Theorem, forever moves in such a way as to prevent the explicit appearance of time, with its inevitable companions, mass, charge, and gravitation, the asymmetric "Gang of Four". Hence time, whether implicit in light or explicit in matter and gravity, is the entropic "prime mover" of the Cosmos. (See: "The Conversion of Space to Time".)

Gravity and Quantum Mechanics

The quantum-mechanical collapse of an electromagnetic wave, which initiates the conversion of free energy to bound energy, switches the position of the temporal component of the wave from an implicit to an explicit state, and conversely for the wave's spatial component - like flipping a coin (see the "Gravity Diagram 2"). This is the quantum-mechanical initiation of the time component of gravity's "location" charge, and it positively identifies in four dimensions the spatial position of the center of mass of the immobile lump of matter, while gauging the magnitude (-Gm) of the gravitational response. Matter (mass) is asymmetrically (locally) distributed in space, having no intrinsic spatial motion and hence no spatial distribution; therefore, matter breaks the "non-local" metric and distributional symmetry of the light which created it. Gravity's symmetry and entropy debts will be simultaneously repaid through the gravitational transformation of matter into light, as in the stars, and Hawking's "quantum radiance" of black holes. See: "The Double Conservation Role of Gravitation".

The temporal residue or time charge which identifies the local coordinate position of matter is unusual in that it is an "entropic" charge, that is, a charge with intrinsic dimensional motion. In the case of time, this is also one-way motion (to protect causality), and at right angles to all three spatial dimensions. Time therefore immediately exits space as it is formed, but because time and space are linked, the intrinsic motion of time drags space after it, collapsing the 3 dimensions of space symmetrically (because time is linked symmetrically to all three) into the zero-dimensional beginning point of the one-dimensional time line,

localized at the center of gravitational mass (See: "New Gravity Diagram") and "A Description of Gravitation".

The constant motion of the entropic time charge causes the accelerated, symmetric collapse of space into the center of any mass; this spatial flow we recognize as a gravitational field. This accelerated spatial motion is the metric "warpage" or "curvature" of the gravitational field. At the center of mass, the collapsing spatial dimensions annihilate each other, always leaving a new temporal residue (which being one-way, cannot self-annihilate). The new temporal residue, the metric equivalent of the annihilated space, moves on down the time line into history, dragging more space after it, producing in its turn a new and metrically equivalent temporal residue, etc., forever. Gravity and time induce each other endlessly, much as the electric and magnetic components of an electromagnetic field induce each other.

Hence while the quantum-mechanical "switch" or "flip" of the implicit temporal component of the electromagnetic wave to its explicit state initiates and gauges the gravitational field, the field is maintained by the subsequent intrinsic motion of the time dimension so established, which drags space after it to destruction at the center of mass, where a new temporal residue, the metric equivalent of the annihilated space and an exact copy of the original, is extracted to repeat forever the self-feeding cycle. Two different processes are thus involved in the 1) initiation and 2) maintenance of a gravitational field, and they unite the quantum-mechanical and relativistic features of gravitation in a single charge, the entropic charge of time. Time is the active principle of gravity's "location" charge. Time is the connecting link between electromagnetism and gravity - the active principle which causes the intrinsic motion of both.

We can relate the microscopic quantum-mechanical "switching" process to gravity's entropy debt (time), and the macroscopic annihilation of space to gravity's symmetry debt ("location"), but such a separation of function is academic, as it is impossible to disentangle the entropy and symmetry components gauged by "velocity c", or their contribution to the gravitational response when light or free energy is transformed to bound energy. Gravity must conserve both gauge functions of c if it conserves either one. Inertial force, gravitation, and entropic intrinsic motion all fall under the sway of Noether's symmetry conservation theorem, due to the double role of c as the gauge of both light's non-local distributional and metric symmetry, and light's entropy drive (light's intrinsic motion). Gravitation is the double conservation response to the loss of light's entropy drive (the intrinsic motion of light), and to the breaking of the "non-local" metric and distributional symmetry of light's energy in space by local, immobile mass. The active principle of gravity's "location" charge is time: *gravity is the spatial consequence of the intrinsic motion of time*. Time is the implicit entropy drive of light, conserved explicitly in matter. Thermodynamic entropy, metric symmetry, and the principle of causality are all bound together in matter's time charge, and all provide a rationale for gravitation. All these debts are paid by the gravitational conversion of bound to free energy in stars, and via Hawking's "quantum radiance" of black holes.

Implicit vs Explicit Time

In its implicit form, time, like the proverbial "bur under the saddle", drives the intrinsic motion of light: the symmetric "wavelength" or spatial component of the electromagnetic wave "flees" the asymmetric "frequency" or temporal component which is an embedded potential of its own nature (frequency multiplied by wavelength = c). Entropy, in the service of energy and symmetry conservation, is the ultimate cause of light's intrinsic motion. In its explicit form, time creates gravitation, spacetime, and the historic conservation domain of information and matter's causal matrix (historic spacetime). Time is therefore the universal driver of the action and entropy of the Universe and its energy forms, in its implicit form causing the expansion of space, in its explicit form causing the contraction of space and the compensatory expansion of history. The difference between the positive entropy of spatial expansion and the negative entropy of gravitational contraction is thus the simple difference between the implicit or explicit state of time - the "heads" or "tails" of the electromagnetic entropy "coin". Similarly, the magnitude of "G" is gauged by the energy difference

between the drive of symmetric spatial (S) entropy (the intrinsic motion of light, as gauged by velocity c) and the drive of asymmetric historical (T) entropy (the intrinsic motion of matter's time dimension, as gauged by velocity T) - in other words, "G" is gauged by the energetic difference between implicit and explicit time: S - T = -G. Whereas "c" gauges the metric relation between space, time, and free energy (light), "G" gauges the entropic relation between space, time, and bound energy (mass/matter).

The gravitational annihilation of space causes the deceleration of the cosmic expansion, since spatial entropy is being transferred to historical entropy. Hence the deceleration of the spatial expansion of the cosmos supplies the gravitational energy to produce matter's time/history dimension. The conversion of spatial expansion to historic expansion, that is, the transformation of spatial to temporal entropy, occurs locally and immediately with the "flip" of the entropy "coin" from implicit to explicit time. The universal expansion decelerates because space is being annihilated rather than created (see: "The Conversion of Space to Time"). As we saw earlier, the concept of the gravitational conversion of space and the drive of spatial entropy (S) to time and the drive of historical entropy (T), can be symbolically represented in a "concept equation" as:

$$-Gm(S) = (T)m$$
$$-Gm(S) - (T)m = 0$$

Finally, due to the operation of Noether's theorem, we note that gravity, like all other charges, seeks to release as much free energy from bound energy as possible, restoring light's non-local distributional and metric symmetry. This is the symmetry debt aspect of gravity, which drives the gravitational conversion of mass to light in stars. In the case of black holes, Hawking's "quantum radiance" carries the process to completion, conserving not only the symmetry of light, but even the symmetry of light's entropy.

Black holes are the observational evidence for the gravitational conversion of space and spatial entropy to time and historical entropy. The "event horizon" of a black hole is a temporal entropy or time surface (the Bekenstein-Hawking theorem). A black hole's "event horizon" is the spatial entropy content of light transformed to time and brought to rest in an asymmetric form, just as the mass of the hole is the spatial energy content of light transformed to bound energy and brought to rest in an asymmetric form.

(For more on this topic, see: "Entropy, Gravitation, and Thermodynamics" and "A Description of Gravitation".)

Links:

Unified Field Theory

[home page](#)

References

Bekenstein, J. D. Black Holes and Entropy. *Physical Review D*, **1973**, 7(8), 2333-46.

Bohm, D. *Wholeness and the Implicate Order*. Routledge & Kegan Paul **1980**, 224 + xv pp.

Brewer, J. W. and M. K. Smith, eds. *Emmy Noether: A Tribute to her Life and Work*. M. Dekker, New York, **1981**, 180 + x pp. + 10 plates.

Hawking, S. W. Particle Creation by Black Holes. *Communications in Mathematical Physics* **1975**, 43 (3), 199-220.

Readings

de Chardin, Pierre Teilhard: *The Phenomenon of Man*. French: Editions du Seuil, Paris, **1955**; English: Harper and Row, New York, 1959.

Close, Frank: *Lucifer's Legacy*. 2000. Oxford Univ Press.

Cronin, J. W. CP Symmetry Violation: the Search for its Origin. *Science* **1981**, 212, 1221-8 (Nobel lecture).

Gowan, J. C. (Sr.) **1975**. ["Trance, Art, Creativity"](#)

Greene, B. *The Elegant Universe*. W.W. Norton & Co. **1999**, 448 + xiii pp.

Greene, B. *The Fabric of the Cosmos*. A. A. Knoph, **2004**, 569 + xii pp.

Gross, D. J. and F. Wilczek. **1973**. Ultraviolet Behavior of Non-Abelian Gauge Theories. Phys. Rev. Lett. 30: 1343.

Gross, Politzer, Wilczek: *Science:* 15 October **2004** vol. 306 page 400: "Laurels to Three Who Tamed Equations of Quark Theory."

Hawking, S. W. Particle Creation by Black Holes. *Communications in Mathematical Physics* **1975**,

43 (3), 199-220.

Lederman, Leon with Dick Teresi: *The God Particle*. 2006. Mariner Books.

Lederman, Leon and Christopher Hill: *Symmetry*. 2008. Promethus Books.

Lovelock, J. E. *Gaia. A New Look at Life on Earth*. 1979. Oxford University Press.

Oerter, Robert: *The Theory of Almost Everything*. Penguin (Plume) 2006.

Pais, Abraham 1986. *Inward Bound: of Matter and Forces in the Physical World*. Oxford University Press, NY

Politzer, H. D.. **1973**. Phys. Rev. Lett. 30: 1346.

Resnick, Robert: *Introduction to Special Relativity*. 1968. John Wiley and Sons, Inc.

Stewart, Ian. "Why Beauty is Truth". **2007**, Basic Books

Trefil, James: *The Moment of Creation*. Macmillian (Collier) 1983.

Weinberg, S. *The First Three Minutes*. Bantam. **1977**, 177 + x pp.

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