Gravity, Entropy, and Thermodynamics
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Gravity is Matter's Memory it Once was Light

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(I recommend the reader consult the "preface" or "guide" to this paper, which may be found at "About the Papers: An Introduction" (section 7); also "Section 2: An Introduction to Gravitation").

Part I

Abstract

The intrinsic motions of light, time, and gravity are primordial forms ("drives") of entropy, causing: 1) the creation, expansion, and cooling of space; 2) the creation, expansion, and aging of history; 3) the creation of historic spacetime, respectively. *The charges of matter are the symmetry debts of light* (Noether's Theorem). Gravity pays the entropy-"interest" on matter's symmetry debt by creating time from space - giving charge conservation an extended, causal significance in the time dimension. Light's spatial entropy drive and expansion funds matter's historical entropy drive and expansion, via the gravitational conversion of space to time; cosmic spatial expansion decelerates in consequence. Gravity pays the energy-"principal" of matter's symmetry debt by the conversion of bound to free energy - via the nucleosynthetic pathway in stars, and via Hawking's "quantum radiance" of black holes. The global gravitational field is reduced, as mass is converted to light; cosmic spatial expansion accelerates in consequence.

Introduction

Gravitation produces a local, spacetime metric (gauged by the universal gravitational constant "G"), imposed upon (and derived from) a global, spatial metric (gauged by the universal electromagnetic constant "c"). The spacetime metric of gravitation - like the spatial metric from which it is extracted - exists for several related conservation imperatives; in the gravitational case, these include: 1) The conservation of energy (1st law of thermodynamics); 2) entropy (2nd law of thermodynamics); 3) causality (the law of cause and effect); 4) the conservation of symmetry (Noether's Theorem). In the material/gravitational universe, entropy, causality, and the conservation of symmetry are necessary adjuncts to the conservation of energy. Entropy, causality, energy and symmetry conservation are all related through the electromagnetic constant "c" and the intrinsic motion of light. Among other functions, "velocity c" regulates or "gauges" the primordial spatial entropy drive of light; the metric symmetry of space; Einstein's "Interval" and causality; and the symmetric "non-local" distribution of light's energy throughout space. (See: "The Tetrahedron Model".)

The rationale for gravity begins with the creation of the Cosmos - the negative energy of gravity is necessary to balance the positive energy of the "Big Bang", so that the "Creation Event" requires zero net energy. This is the time when gravity is joined with the other forces in equal strength, and bound energy (mass) is created from free energy (light) and the structural metric of spacetime through the combined action of the four forces of physics. Initially, bound energy is in the form of matter-antimatter pairs, so that creation is initiated from a state of zero net charge as well as zero net energy. Beginning in such a state of complete neutrality (perhaps as a giant quantum fluctuation of the vacuum, an "inflationary bubble", or Divine Fiat), the Universe can only evolve into a state of complete conservation. (While such a huge quantum fluctuation might be unthinkable in our own universe, it might not be so unusual in the Multiverse.)

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 space to time (the role we see on Earth); 2) the conversion of bound to free energy (in stars and via Hawking's "quantum radiance" of black holes). The first role conserves the entropy drive ("intrinsic motion") of light (free electromagnetic energy); the second role conserves light's "non-local" distributional and metric symmetry (obeying Noether's Theorem). These secondary conservation roles are natural consequences of the mode of action of gravity's primary role, which is the creation of negative energy and entropy via the contraction and destruction of space (creating time), in contradistinction to the expansion and creation of space by the positive energy and entropy of light.

Gravity satisfies its energy, entropy, and causality conservation role immediately and directly, through the creation of time - via the annihilation of space and the extraction of a metrically equivalent temporal residue (see: "The Conversion of Space to Time"). Time serves as the primordial entropy drive of bound energy, and also protects Einstein's "Interval" (via "Lorentz invariance" and the covariance of time with space) - conserving the principle of causality in material systems with relative motion. (See: "Global-Local Gauge Symmetry in Gravitation".) Time is also necessary to accommodate the energy accounts of matter in relative motion. The intrinsic motion of time produces history, the conservation domain of matter's causal information matrix, web, or network (historic spacetime). The spherically symmetric gravitational field vanishes at its center, not only producing time by the annihilation of space, but also ensuring that no net spatial motion accrues to the gravitating mass (observing energy conservation).

Gravity satisfies its symmetry conservation role through the conversion of bound to free energy (in stars, for example), but is in no hurry to do so. The symmetry debts of massive particles, which are generally held through time in the form of conserved charges, may be paid or discharged on an indefinite schedule - unlike energy conservation debts, which must be paid immediately (as in the inertial and entropic aspects of gravitation). Gravitational symmetry debts are paid by the conversion of bound to free energy - mass to light - in our Sun and the stars. The process goes to completion in Hawking's "quantum radiance" of black holes. This final and complete gravitational conversion of mass to light pays all matter's energy, entropy, and symmetry debts simultaneously.

Inertial forces arise as metric symmetry debts which behave like raw energy debts, unlike the symmetry debts of massive particles which are held through time in the form of charges. A fundamental difference therefore characterizes spatial vs temporal symmetry debts. Gravitation bridges this distinction, however, converting the spatial entropy drive of light (the intrinsic motion of light, which is wholly inertial in character) to the temporal entropy drive of matter (time's intrinsic motion, which is partly inertial and partly charge-like in character (because time is a "local" metric symmetry debt)). Thus gravitation has both a spatial, inertial character as a symmetry debt, and a temporal, charge character as an entropy debt. The gravitational "location" charge, whose active principle is time, connects time with space, symmetry conservation with entropy conservation, and gravity with the other charges and forces of physics through "Noether's Theorem". *The charges of matter are the symmetry debts of light*. Time is the entropic charge of the gravitational force. *A gravitational field is the spatial consequence of the intrinsic motion of time*. Time and gravity induce each other in an endless entropic conservation loop. (See: "The Double Conservation Role of Gravitation".)

The gravitational symmetry debt is in response to the broken symmetry of light's "non-local" distribution in space, when light is converted to any form of bound energy. The gravitational entropy debt is in response to light's lost intrinsic motion, arising from the same cause and simultaneously with the symmetry debt. The gravitational charge is designated "location"; time is the active principle of gravity's "location" charge. Time's intrinsic (entropic) motion replaces light's intrinsic (entropic) motion; the time dimension specifies the 4-dimensional location of immobile, undistributed matter, and as these charges are summed and concentrated, the total amount and density of bound energy as well.

The ultimate purpose of a dimensional metric, whether spatial and global (as gauged by "c"), or temporal and local (as gauged by "G"), is the conservation of energy. This role is fulfilled by gravitation through the production of bound energy's time dimension via the annihilation of space and the extraction of a metrically equivalent temporal residue. Gravity converts light's spatial metric and entropy drive (the intrinsic motion of light) into matter's historical metric and entropy dive (the intrinsic motion of time). The simple entropic expansion and cooling of space is gravitationally converted to the compound entropic expansion and aging of historic spacetime.

Gravity (immediately) pays the entropy-"interest" on matter's symmetry debt by extracting time from space, in consequence decelerating the cosmic spatial expansion (cosmic historical expansion is funded by and replaces cosmic spatial expansion). Gravity (eventually) pays the energy-"principle" of matter's symmetry debt by converting bound to free energy in stars and by Hawking's "quantum radiance" of black holes, actually reversing the contractile effect of its entropy conservation role and causing an "acceleration" of the cosmic expansion (due to a reduction in the total gravitational energy of the cosmos) - as recently observed. (See: "Does Light Produce a Gravitational Field?"; and "Global-Local Gauge Symmetries in Gravitation").

Four Physical Principles

In this paper I will examine the role of gravitation in the context of 4 physical principles (conservation laws and their corollaries): energy conservation, entropy, causality, and symmetry conservation.

The first law of thermodynamics asserts the conservation of energy: in any isolated system, the total energy remains the same, regardless of transformations. The second law of thermodynamics concerns entropy: in any isolated system, the capacity for "work" by that system must decrease (or at the very least, not increase) over time, as by expansion and/or cooling.

According to standard formulations of the subject, three conditions characterize the change of entropy within an isolated system [1]:

1) the change in entropy depends only upon the difference between the initial and final states of the system;

2) in reversible systems the entropy change is zero;
3) in irreversible systems the entropy change is positive.

In addition to causality (the law of cause and effect) and the first and second thermodynamic laws, the "Tetrahedron Model" requires a 4th conservation principle, the conservation of symmetry, which is not a thermodynamic law, but is nevertheless related to causality and both the first and second laws in significant ways. This principle of conservation was mathematically formulated (1918) by Emmy Noether and is known as "Noether's Theorem". It states that in a continuous multicomponent field, such as the electromagnetic field (or the metric field of spacetime), whenever we find a symmetry we will find an associated conservation law, and vice versa: conservation laws have associated symmetries. Hence symmetry's relationship to the first law of thermodynamics. I like to think of Noether's theorem as the "truth and beauty theorem", for it is essentially a mathematical translation of Keats' poetic intuition (1819) that "Beauty is truth, truth beauty...", where truth is conservation and beauty is symmetry [2].

Symmetry conservation is also related to the second law of thermodynamics because symmetric systems generally have greater (positive) entropy than asymmetric systems; hence symmetry conservation drives toward higher entropy states (random states are highly entropic, highly probable, and highly symmetric). This is especially evident in the tendency of all forces to convert bound energy to free energy, as light has both the greatest symmetry and the greatest positive entropy of any energy form. Stellar processes and Hawking's "quantum radiance" of black holes are specific examples of entropic systems of lesser symmetry (matter and time) being spontaneously converted to entropic systems of greater symmetry (light and space). The gravitational evaporation of black holes is the ultimate expression of "Noether's Theorem", in which it is demonstrated that even the symmetry of entropy is conserved.

Symmetry conservation is most familiar to us in the guise of charge (and spin) conservation, since *the charges of matter are symmetry debts of light*, debts incurred during the conversion of symmetric light to asymmetric matter during the "Big Bang" (or in any subsequent process converting free to bound energy). The "inertial" forces of the spacetime metric are another common expression of Noether's theorem and the relation between symmetry and conservation. (See: "Symmetry Principles of the Unified Field Theory".) The principles of entropy and symmetry conservation are also physically connected by the phenomena of both light and gravitation. The electromagnetic constant c (the "velocity of light"), is the "gauge" (regulator, scalar) of both light's symmetric "non-local" energy state and light's entropy drive, as light's intrinsic motion is an expression of both - creating, expanding, and cooling space on the one hand (the entropy drive), while simultaneously suppressing the temporal dimension, maintaining metric symmetry, and establishing the "non-local" distribution of light's energy throughout spacetime on the other hand (the symmetry gauge). In turn, gravitation is both conserving light's entropy drive in the conversion of light's expansive spatial domain to matter's expansive historical domain, and conserving light's "non-local" symmetric energy state in the conversion of bound to free energy (as in stars and Hawking's "quantum radiance" of black holes).

Pure and Mixed Forms of Entropy

Spatial, "Thermal", or "Work" Entropy vs Temporal, "Cold", or "Stored" Entropy

See: "Spatial vs Temporal Entropy".

Entropy exists in several forms in nature, always with the same purpose, to prevent violations of energy conservation. Unless the context indicates otherwise, when I refer to "entropy" in these papers (especially in such phrases as "space and spatial entropy" or "time and historical entropy"), I am referring to entropy in its most primordial or pure form, as the intrinsic motion of light "gauged" or regulated by "velocity c" (causing the expansion and cooling of space in the case of "spatial entropy"), or as the intrinsic motion of time gauged or regulated by "velocity T" (causing the expansion and dilution of history or historic spacetime in the case of "temporal entropy"). "Velocity T" is itself gauged by "c": the electromagnetic inertial metric of spacetime is gauged by the electromagnetic constant "c", such that one second of temporal duration is metrically equivalent to 300,000 kilometers of spatial distance (approximately).

Thermal or "work" entropy, as generally defined, is the energy in an isolated system which *on principle cannot be transformed to work*. Entropy characterizes the degradation of energy inherent in the operation of any cyclic engine or process of energy transformation, typically manifest as "heat loss": the same energy cannot be used twice to produce the same net work. These ideas imply the conservation of energy and the impossibility of a "perpetual motion machine". Entropy is a corollary of - and a principle safeguarding - energy conservation, allowing the transformation of energy. Entropy prevents the abuse of energy; without the principle of entropy, energy conservation would prevent any use or transformation of energy at all.

"G" (the universal gravitational constant) gauges the strength of the connecting link or conversion factor between the primordial forms or "drives" of spatial and temporal entropy: gravity converts space and the embedded drive of spatial entropy (the intrinsic motion of light) to time and the embedded drive of historical entropy (the intrinsic motion of time). Whereas the electromagnetic constant c is the gauge of the *metric* relation between space, time, and free energy (light), the gravitational constant G is the gauge of the *entropic* relation between space, time, and bound energy (mass). When free energy is converted to bound energy, the entropy-energy driving the spatial expansion of the universe is gravitationally converted to the entropy-energy driving the historical expansion of the universe; in the process, space is gravitationally annihilated, decelerating the spatial expansion accordingly. (See: "A Description of Gravitation"; see also: "A Spacetime Map of the Universe".)

So essential is the connection between entropy and energy conservation that entropy is an embedded physical characteristic of energy ("primordial" entropy drives as gauged by c, T, and G). "Primordial" entropy drives are expressed as the intrinsic motion "c" of free energy (the velocity of light - primary mode), and as the intrinsic motion "T" of bound energy's time dimension (the metric equivalent of velocity c - secondary mode). These two "primordial" entropy drives are connected by gravitation, which converts one into the other (in either direction), sometimes performing both conversions simultaneously, as in the solar conversion of space to time (entropy conservation), and mass to light (symmetry conservation). The intrinsic motions c, T, and G are all physical expressions of entropy embedded in their energy forms (free and bound electromagnetic energy).

The effectively "infinite" velocities of both light and time are necessary attributes of their role as the entropy (and causality) drives of free and bound energy. These "infinite" velocities guarantee the increase of spatial and historical entropy, while simultaneously preventing violations of energy conservation and/or causality via fast spaceship or "time machine". Hence these intrinsic motions also effectively close and protect the borders of the dimensional conservation domains they create (space, history). The dimensions of spacetime are conservation domains created by the primordial entropy drives of electromagnetic energy - whether free energy (light and space) or bound energy (matter and history). Similarly, gravitation closes the borders of its composite spacetime domain via the "event horizon" and central "singularity" of black holes, likewise preventing conservation violations (perhaps via intrusive "wormholes", or via the leakage of energy into other dimensions or universes). In the black hole, gravity takes over the entropic functions of both c and T - "freezing" light and time - just as gravity takes over the molecular and nuclear binding functions of atomic matter. (Within the "event horizon", the gravitational metric of bound energy functionally and completely replaces the electromagnetic metric of free energy, including causal and entropic relations.) Proton decay takes place at the central singularity, and the black hole is filled with gravitationally bound light, the limit of the gravitational metric and the temporal entropy domain. Inside the black hole, matter becomes co-extensive with its temporal domain, just as outside the black hole, light is co-extensive with its spatial domain. We can therefore also expect that matter will become subject to vitiating forces of temporal entropy inside the hole, just as light is subject to vitiating forces of spatial entropy outside the hole. This expectation (among other considerations) leads us to expect that proton decay is commonplace inside black holes.

The gravitational conversion of space and the drive of spatial entropy to time and the drive of historical entropy is physically demonstrated by black holes, and theoretically suggested by the Bekenstein-Hawking formula relating the surface area of a black hole to its entropy content. (See: Jacob D. Bekenstein: "Information in the Holographic Universe". *Scientific American* August 2003 p. 58-65.) (See: "The Conversion of Space to Time"; see also: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".)

A Universe of Light

Consider the birth of a universe containing only light (free electromagnetic radiation) and no matter. Such a universe will expand (and cool) at velocity c due to the intrinsic spatial motion of light. Why?

The expansion of the "light universe" is not driven by energy conservation, for at any given moment the total energy of this light universe remains the same as it was at the beginning, the constant product of a declining temperature but increasing volume. That is, the light universe does not need to expand in order to conserve energy; energy conservation *regulates* the expansion but does not demand it. Apparently, the expansion of the light universe is likewise not driven by the conservation of energetic symmetry - since a "hot" light universe is just as symmetric as a "cool" light universe, so as in the case of the first law, symmetry conservation seems to be only a regulator, not a driver, of this process (this appearance is deceptive, however - see below). Finally, causality cannot drive the expansion, since light, having no time dimension, is completely acausal. In the light universe, energy conservation will regulate the constant product of temperature and volume by linking the energetic and metric parameters of energy through the electromagnetic constant c (frequency multiplied by wavelength = c). Energetic symmetry conservation (Noether's Theorem), also gauged by c, will prevent the conversion of light and space to mass, time, charge, and gravitation. The spontaneous creation and annihilation of virtual particle-antiparticle pairs in the vacuum is paradigmatic of symmetry conservation by the electromagnetic force, preserving the: 1) energetic (massless and chargeless); 2) metric (timeless and inertial); and 3) distributional (non-local and simultaneous) symmetry of free energy.

However, the second law of thermodynamics (entropy) demands the spatial expansion and is therefore the thermodynamic driver of the process, since the second law requires that the capacity for work of this isolated system of radiation must decline over time, requiring the light universe to cool, which it can only do by expanding. Therefore, we see that entropy is the thermodynamic reason why the light universe must expand, and why light must have an "intrinsic" (entropic) spatial motion. In addition, because "velocity c" gauges both the entropy drive and the symmetric energy state of light, we see that symmetry conservation provides half of the drive and rationale for light's intrinsic motion - free energy must move at velocity c if it is to remain in its "non-local" symmetric energy state, vanishing time, mass, charge, and gravitation. Energetic symmetry and entropy, in the case of light, are linked by "velocity c".

We can also see that the second law (and symmetry conservation) require a dimensional or metric structure (space) in which to operate (expand). Hence we can attribute the dimensional parameters of our cosmic system to symmetry conservation and the second law - the first law requires only that energy and its dimensional expression (if it is to have one) be linked in such a way that conservation is achieved - as the constant product of temperature and volume, for example, which of itself neither implies nor requires expansion.

The function of the second law is to permit change. Without the second law the universe could not spend or transform its energy capital - it could not act or evolve; it would be static rather than dynamic. Together, the first and second laws allow change within a dimensional system which nevertheless conserves energy. Symmetry conservation, which also regulates the metric parameters of the cosmic expansion, allows this system of conserved change to take a decisive further step - the conversion of light to matter - through the addition of a system of conserved charges, *the symmetry debts of light*. It is symmetry conservation that translates energy into information (the charges of atomic matter), while entropy allows the system to change and perform work. A third conservation parameter - raw energy conservation - regulates or "gauges" the conversion of free to bound energy: $E = h\nu$ (Planck); $E = mcc$ (Einstein); $h\nu = mcc$ (deBroglie). With bound energy (mass, matter) comes gravitation, time, the law of cause and effect, and the causal information "matrix" (web, network) of matter (historic spacetime).

Through a system of alternative charge carriers (leptons, neutrinos, and mesons), and through the asymmetric interactions of the weak force "Intermediate Vector Bosons" ("IVBs"), the initial symmetric energy state of light, its metric, and its particle-antiparticle form is broken, creating asymmetric matter. (See: "The Higgs Boson and the Weak Force IVBs".) Finally, the gravitational charge of matter creates time, the dimensional parameter in which charge conservation and causal linkages have meaning, and the energy accounts of matter's relative spatial motions can be accommodated. Gravitation pays the entropy "interest" on bound energy's symmetry debt by producing matter's time dimension from the expansive energy or spatial entropy drive of the universe (by the annihilation of space and the extraction of a metrically equivalent temporal residue). Thus it is ultimately light's spatial entropy drive and expanding spatial domain which provides the energy for matter's temporal entropy drive and expanding historical domain; gravity decelerates the spatial expansion accordingly. A new, complex universe of light mixed with matter, negentropic and causal, containing information in the form of charge, begins its historic, evolutionary adventure as it slowly awakens to itself while returning the "stored" energy of its asymmetric material component to "working" and "useful" symmetric free energy. (See: "The Origin of Matter and Information".) During the long "working life" of the Universe, gravity repays the energy-"principle" of matter's symmetry debt, converting bound to free energy in stars and ultimately and completely, via Hawking's "quantum radiance" of black holes. Black hole "evaporation" represents the final fulfillment of Noether's symmetry conservation theorem. As the mass of the Cosmos is converted to light, its associated gravitational energy is accordingly reduced, and the cosmic expansion appears to "accelerate" - as recently observed.

Energy Conservation

The electromagnetic constant "c" gauges (regulates) both the entropy drive of light (light's intrinsic dimensional motion), and the "non-local" distributional symmetry of light, including the metric symmetry of spacetime. The metric is the measured relationship between the dimensions. We take for granted the fact that (stationary) meter sticks do not vary in length, nor (stationary) clocks vary in rate, regardless of their orientation or location in space or time. Clocks and meter sticks in Hong Kong run at the same rate and have the same length as clocks and meter sticks in New York, and could be freely exchanged (now or next year) without any measurable difference. Furthermore, the relationship between the length of a meter stick and the rate at which a clock runs is similarly invariant. This fixed, simple dimensional relationship is absolutely necessary for the conservation of energy; without it, velocity, momentum, and energy of all descriptions would vary chaotically from place to place, time to time, and according to orientation. Hence the stable metric displays a symmetry (a sameness) with respect to location and orientation in space or time, and this inertial symmetry is a manifestation of energy conservation - perhaps our most fundamental example of Noether's theorem and the connection between symmetry and energy conservation. We become aware of the breaking or distortion of this metric symmetry in the presence of gravitational fields or the inertial ("g") forces due to acceleration - but these are both phenomena associated with time, relative motion, and the asymmetric realm of matter. Similarly, distortions of the metric due to relative motion (as discovered by Einstein) are phenomena of matter, necessary to conserve the causal relations of bound energy forms in relative (rather than absolute) motion ("Lorentz Invariance").

In the light universe, time, gravitation, charge, relative motion, and the inertial forces which attend mass-matter do not exist. What inertial force does exist can be said to maintain the invariance of c and the metric symmetry of space. Without a metric, there would be no structure to regulate the expansion of the universe such that its temperature and volume yield a constant product over time, in satisfaction of the first law. "Velocity c" regulates ("gauges") the metric such that one second of temporal duration is metrically equivalent to (approximately) 300,000 kilometers of linear space. In other words, the velocity of light is a natural expression of metric symmetry, the inertial relationship between the three spatial dimensions, and between space and time. The magnitude of c cannot vary or the first law cannot produce the constant product of volume and temperature in the expanding universe. Without the regulating presence of the metric, every photon might have a unique velocity; "rogue" or sourceless gravitational fields could arise, producing net energy; energy conservation would be impossible.

Einstein discovered that light has no time dimension, that at velocity c the "clock stops" and space shrinks to nothing in the direction of motion. Light is a 2-dimensional transverse electromagnetic wave whose intrinsic motion sweeps out a third spatial dimension. The light universe does not contain an explicit (local) time dimension, it is purely spatial, which makes sense in that being one-way, time is an asymmetric dimension which would destroy the metric symmetry of light-space. The essential meaning of the electromagnetic constant "c" is that c is the conservation/symmetry/entropy gauge of the spatial metric, which functions to prevent the formation of asymmetric, massive matter, charge, and the one-way time dimension. The dimensional and energetic parameters of this electromagnetic conservation domain are thoroughly linked such that the wavelength of light (its spatial expression) multiplied by the frequency of light (its temporal expression) always equals the constant c. Nevertheless, even in the light universe, a "global" temporal dimension must be at least implicitly present to regulate the expansion and cooling. Entropy (and energy conservation) require the presence of time, whether implicitly or explicitly expressed. (See: "The Conversion of Space to Time".)

Obviously, time is implicit in the "frequency" of light, but at "velocity c", time is prevented from becoming explicit (conserving metric symmetry). The seed is present, but its growth is suppressed; indeed, time would be required in its explicit and local aspect should light assume its asymmetric particle form and produce matter. In fact, we need to discover the origin of the time dimension in light if we are to build a truly unified theory of free plus bound electromagnetic energy and its compound dimensional conservation domain (spacetime), a theory which traces the origin of all forces back to light. "Frequency" is this origin in the case of time, as well as of the bound energy content of matter - in the latter case when combined with the dimensional/structural metric of space (as suggested by DeBroglie's equation: $h\nu = mcc$). In turn (as we shall see below), time is the source of gravity. (See also: "The Higgs Boson vs the Spacetime Metric".)

In the case of matter, local time is explicitly required by energy conservation to protect causality and to keep the energy accounts of massive particles in relative motion (for example, the conservation of momentum, in which the energy content of matter depends upon its variable and relative velocity, where velocity = distance divided by time). Light does not explicitly require time for the same purpose, since light's absolute (non-relative) velocity never varies: the energy content of light varies instead with its frequency (according to the Einstein-Planck formula: $E = h\nu$). Finally, because massless light is "atemporal" and "non-local", light is also "acausal". Massive bound energy, in contrast, is local, temporal, and causal. Einstein had to formulate the dimensional flexibility of Special Relativity (slow clocks and shrinking meter sticks - the covariance of space with time: "Lorentz Invariance") to rescue the principle of causality and the invariance of the "Interval" (an invariant measure of distance in 4-D spacetime) from the relative motion of matter. The "absolute" and invariant motion of light requires no such accommodation (light's "Interval" = zero).

It is the ever-present threat of time, implicit in the very nature of light (as "frequency"), which propels the electromagnetic wave forward in space to protect its "non-local" distributional and metric symmetry. The flight of space ("wavelength") from time ("frequency") produces the intrinsic (self-motivated) motion of light, a symmetric spatial state of energy fleeing an asymmetric temporal state which is an internal potential of its own nature (the proverbial "bur under the saddle"). Since the intrinsic motion of light also produces the characteristic expansion of spatial entropy, we see again that energy conservation, symmetry, and entropy are all related and share a common factor, c. Hence we say that both metric symmetry conservation and entropy, in the service of energy conservation, are drivers of the spatial expansion of the light universe, just as we say that (among other roles) velocity c is the gauge of light's entropy drive and of light's "non-local" distributional symmetry. Time is both the implicit entropy drive of light and the explicit entropy drive of matter.

Our material universe comes into being through the intersection of a symmetric conservation domain (light, space) with an asymmetric conservation domain (matter, history). The metric gauge c is a symmetry regulator preventing the intersection of space and time, and thus preventing light from manifesting as matter. (See: "The Origin of Matter and Information".)

Symmetry and the "Interval"

The "Interval" is Einstein's mathematical formulation of an invariant quantity of spacetime separating two discrete events. Due to their relative motion and the finite speed of light, some observers of these events will see them separated by more space, while others will see them separated by more time, and moving observers will generally not be able to agree on precisely when or where the events occurred. However, regardless of the observer's motions (including accelerated motions), if their observations are entered into Einstein's mathematical formula, they will all find the same "Interval" ("Lorentz Invariance"). It is the crucial function of Einstein's "Interval" to rescue causality from the plastic, co-varying dimensions of Einstein's relativistic spacetime [3]. (See: "The Paradox of the Traveling Twins".)

Einstein realized that the Interval of light equals zero - which is his essential mathematical formulation of light's "non-local" symmetric energy state and the fundamental role of c as a symmetry "gauge" and metric regulator. Light's "zero Interval" means that light is "non-local" - its position in spacetime cannot be specified - hence (in its own reference frame) light must be considered to be everywhere within its conservation domain (space) simultaneously. The reason the Interval of light is zero is that light lacks both a time dimension and one spatial dimension (in the direction of its forward motion). You cannot specify a location in 4-dimensional spacetime if you lack even one of the 4 necessary coordinates, much less two. Lacking both a time and distance dimension, light has forever to go nowhere - which explains how light, in its own reference frame, can have an effectively "infinite" velocity, and be everywhere simultaneously - the symmetric "non-local" state of free energy.

Of various symmetries associated with light's zero Interval or "non-local" energy state, two are of special importance for our discussion of gravitation. The first is light's lack of an asymmetric time dimension, resulting in the metric symmetry of space - there are no energetically preferred spatial dimensions in light-space (compare this with the energetically favored direction "down" in the gravitational space of matter, or the one-way "forward" direction of time). Secondly, because light is everywhere within its spatial domain simultaneously, light's energy is distributed symmetrically throughout its conservation domain (compare this with the lack of distributional symmetry in space of the highly concentrated and immobile "local" energy state of mass-matter or bound energy). Light itself does not produce a gravitational field - since light is non-local, a gravitational field could not center itself upon any fixed position or specifiable location, and an uncentered gravitational field is a violation of energy conservation (because such a field would produce net energy). Also, light has no time dimension, and hence has no need of a gravitational field to produce one. (See: "Does Light Produce a Gravitational Field?")

When light (free electromagnetic energy) is converted to matter (bound electromagnetic energy), these metric and distributional symmetries (among others) are broken. In accordance with Noether's theorem, the broken symmetries of light are conserved as time and the gravitational forces of spacetime (in the case of light's broken entropic, metric, and distributional symmetries), and as the various charges (and spin) of matter (in the case of light's broken massless symmetry). The principle of symmetry conservation is therefore most familiar to us (after symmetry-breaking and the creation of matter) through the principles of charge conservation, gravitation, the inertial "g" forces of acceleration, and time; before symmetry-breaking and before the creation of matter, we see (in theory) symmetry-conserving principles manifesting in light's intrinsic motion, metric symmetry, the inertial forces of space, and the suppression (by the symmetry gauge "velocity c") of virtual particles, mass, charge, time, and gravity. It is the broken "non-local" metric and distributional symmetries of light that give rise to the "location" charge of gravitation, a charge whose active principle is time. The function of all conserved charges is to produce forces which will (immediately or eventually) return the material asymmetric system to its original symmetric state (light). Our sun is the archetypical example of this ongoing process - stars use the natural forces generated by the charges of matter to convert asymmetric mass back to symmetric light (Stephen Hawking's "quantum radiance" takes this spontaneous, gravitationally driven process to completion in "black holes", completely paying the gravitational symmetry and entropy debt of matter). See: "Symmetry Principles of the Unified Field Theory".

The role of symmetry conservation is twofold: 1) to prevent the devolution of the acausal symmetric light universe to a causal light-and -matter universe containing asymmetric mass, charge, time, and gravitation (this preventive function of symmetry conservation is typically manifest through the role of electric charge in the annihilation reactions of matter-antimatter particle pairs, whether virtual or real). 2) To conserve through time (should the annihilations mentioned above fail) the symmetry debts of light and space as the charges (and spin) of matter (including the gravitational "location" charge), so this information may be used, through the forces generated by those charges, to return matter to its original symmetric energy state (light). It is thought that the symmetric state of our electromagnetic system was broken early in the "Big Bang" by asymmetries inherent in weak force interactions between matter vs antimatter [4]. (See: "The Origin of Matter and Information".)

The central problem to be solved by the manifest universe of matter is this: how to return to its original symmetric energy state of light given the absence of antimatter? The information contained in the charges of matter (the symmetry debts of light) is sufficient for the task (this is the ultimate rationale for information), but requires an additional dimension or "degree of freedom" (time), in which to act. Time will be supplied by gravity paying the entropy-"interest" on matter's symmetry debt with energy withdrawn from the spatial expansion of the Cosmos. The slow return to its symmetric state of the great energy stored in matter (E = mcc) provides both the time and free energy for biological systems such as ourselves to evolve and meditate upon our origins - "we are star-stuff contemplating the stars" as Carl Sagan famously observed. Life is the information pathway by which the Universe explores itself and becomes self-aware, evolving new modes of creativity and new forms of beauty. We are the Universe in its self-referent, sentient, conscious mode.

Part II

Matter

In contrast to the pure and simple "light universe", imagine now the beginning of a compound universe such as our own, composed of both light and matter (free and bound forms of electromagnetic energy). In the beginning, the universe has its greatest capacity for "work", since its energy is at its most concentrated, and its temperature is at a maximum. The "work done" at the beginning of our universe is the creation of matter from light (this qualifies as "work" since an asymmetric state is created from a symmetric one - the ensuing dispersal of material particles against their mutual gravitational attraction conforms to the more usual definition of thermodynamic "work"). Never again will the universe be hot enough to create matter (unless it collapses in a "Big Crunch"). The creation of matter provides the storehouse of bound energy whose subsequent slow release fuels the evolution of the material universe and life. How does the creation of matter affect the cosmic march of spatial entropy as manifested (in the "light universe") through the intrinsic motion of light and the expansion and cooling of the spatial cosmos?

Matter is created (during the "Big Bang") by the interaction of high energy light with the metric structure of space (and by the combined action of the four forces of physics), creating particle-antiparticle pairs, which subsequently decay asymmetrically via the weak force, producing a tiny residue of matter. (See: "Table of the Higgs Cascade".) These asymmetric weak force decays involve the "Intermediate Vector Bosons" (IVBs) of the weak force, as scaled or gauged by the ""Higgs" boson". But matter has no (net) intrinsic spatial motion, and therefore cannot participate in the expansion of the universe and light's spatial entropic march. Nevertheless, like every form of energy, matter must have an entropy drive, for reasons of energy conservation. In the case of bound energy, that entropy drive is the intrinsic motion of time, produced by matter's intrinsic gravitational field (gravity annihilates space, extracting a metrically equivalent temporal residue). (See: "The Conversion of Space to Time".)

The conversion of light to matter breaks the symmetric state of the light universe both dimensionally and energetically. Dimensionally, bound energy is not integrated with space, as it lacks intrinsic spatial motion "c". Instead, matter's time dimension moves with an intrinsic motion that is the metric and entropic equivalent of the intrinsic motion of light - as required by the conservation of energy. Matter's time dimension: 1) allows the existence of bound energy and the interaction of bound and free energy; 2) provides bound energy with an entropy drive; 3) protects causality; 4) accommodates the energy accounts of matter in relative (rather than absolute) motion. The "intrinsic motions" of light and time (as gauged by "velocity c" and "velocity T") are the entropy drives of free and bound energy, respectively. Neither the intrinsic motion of light nor the intrinsic motion of time has any dependence on the quantity of energy they happen to be associated with. They are simply the entropy drives of their respective energy forms, creating the dimensional parameters for the conservation domains of free and bound energy (space and history - historic spacetime).

The primordial symmetry between matter and antimatter - light's particle-antiparticle form - is broken by the weak force during the "Big Bang". But matter is very much more than a massive, inert lump of concentrated, asymmetric light energy. Matter is created not only with a time dimension and gravitational field, but with various other charges, intrinsic motions, and internal structures as well. Time, spin, gravity, and the various charges of matter can all be characterized as symmetry debts of light, the charge of interest here being time and the "location" charge, the source of the gravitational field.

Gravitation is the most universal charge of matter, carried by any bound form of energy, that is, any form of energy which lacks intrinsic motion c, or whose spacetime location can be specified around a local center of mass, or which has a time dimension ("Interval" > zero). All energy forms have either intrinsic motion c or a time dimension with intrinsic motion T; if they have a time dimension, then they also have intrinsic motion G (gravitation). Time, charge, and gravitation are the universal companions of mass or bound energy, and it is more than coincidence that these four asymmetries (the asymmetric "gang of four") are always found together - indeed, they are linked in a causal chain. (See: "The Tetrahedron Model".)

Conservation Consequences of the Creation of Matter

Let us return to the birth of our material universe and imagine again the initial expansion, beginning with pure light (free energy). The expansion (driven by the intrinsic motion of light) is faithfully obeying energy and symmetry conservation and the march of (positive spatial) entropy when suddenly (due to weak force symmetry-breaking) some of its free electromagnetic energy is converted to bound electromagnetic energy. This conversion of light to matter poses a number of interrelated conservation problems for the Cosmos. I will try to enumerate and separate a few of them as best I can in what follows.

First, there is the problem of raw energy conservation. This is resolved by storing the raw energy of light in the form of the mass and momentum of particles. However, unlike light, a massive particle requires an explicit time dimension to provide an entropy drive, protect causality, and to balance its energy accounts - all problems related to relative (rather than absolute) motion, as mentioned earlier. Since no explicit (local) time dimension exists in the light universe, one will have to be created. However, the creation of a time dimension will require an energy source - just as space requires the entropy-energy (intrinsic motion) of light for its creation, and cools in consequence of its expansion. Dimensional conservation domains are the creations of entropy-energy, whether space, history, or historic spacetime. We will return to this point.

Second, there is the problem of symmetry conservation. The symmetry of light must be conserved no less than its raw energy (Noether's Theorem). This problem is addressed in two ways: 1) the matter-antimatter symmetry of light's particle form is conserved through the creation of the conserved charges of matter (including spin); 2) the non-local distributional, entropic, and metric symmetry of light's wave or dimensional (spatial) form is conserved through gravitation and the inertial forces of spacetime. Gravitational charge is the "location" charge engendered by the conversion of light to mass, as immobile bound energy breaks the symmetry of the non-local spatial distribution of light's energy. The active principle of gravity's "location" charge is time, whose intrinsic motion is the physical cause of gravitation; time also serves as matter's entropy drive. The gravitational force is produced by the activity of a charge or symmetry debt, and therefore is related to the other forces through the "conservation umbrella" of Noether's Theorem. Gravity is distinguished from the other forces by the weakness and entropic nature of its charge (time), and its multiple conservation roles (entropy, symmetry, causality, and energy conservation).

Third, there is the entropy problem referred to above. In the purely light universe, entropy had a spatial expression (the expansion and cooling of space), produced by the intrinsic motion of light. Matter has no intrinsic spatial motion, hence its bound energy form has no spatial expression of entropy. Since entropy is a necessary corollary of the conservation of energy - creating dimensional conservation domains and preventing the "misuse and abuse" of energy - the entropy of light must also be conserved and transferred to matter, along with light's raw energy (as mass) and symmetry (as charge). In matter, the alternative, conserved form of light's entropy is time ("intrinsic motion c" becomes "intrinsic motion T"): gravity is the dimensional force producing the transformation of light's spatial entropy drive to matter's historical entropy drive. We have already noted how the entropy drive and symmetry gauge of light are related through c, such that when one is conserved, so is the other. To this combination, with the creation of matter, we can add causality, since light and time are alternate forms of causal linkage, and time is the active principle of gravity's "location" charge. Causality and entropy are simultaneous conservation roles for the intrinsic motion of time in bound energy, just as symmetry and entropy are simultaneous conservation roles for the intrinsic motion of light in free energy. Causality in matter is therefore an analog of symmetry in light - a proportionality which we intuitively recognize through the notion of "fair play", "karmic justice", or symmetry with regard to the evenhanded application of law and the suitability of reward or punishment (the "Golden Rule" of social behavior and justice is the classic example).

Nature's solution to matter's entropy problem, which satisfies the requirements of causality, the first and second thermodynamic laws, and Noether's Theorem all at a single stroke, is to create time from space by means of the gravitational force. This "internal" metric solution also addresses the problem of how to transfer light's entropic flow to matter's entropic flow (annihilate space, thereby converting the implicit temporal entropy drive of light and space to the explicit temporal entropy drive of matter and history), where the energy to create the time dimension will come from (subtracted from the spatial expansion of the Cosmos), and how to equilibrate and connect the metric of the spatial (free energy) and temporal (bound energy) conservation domains (G connects mass to space via the intrinsic motion of time, causing the annihilation of space and the transformation of light's spatial entropy drive into the metrically equivalent temporal entropy drive of matter). The intrinsic motions of time and light are metrically (and entropically) equivalent, conserving the spatial entropy drive or intrinsic motion of light as the historical entropy drive or intrinsic motion of time: "time flies". Time moves in history as fast as light moves in space. (See: "The Time Train".)

Gravity is the space-consuming, contractile (negentropic) step in the transfer process, in which an implicit entropy component of time is taken from space (via the annihilation of space), and given to matter as a "charge" of explicit time. The energy is supplied by the light-entropy or intrinsic motion inherent in the space consumed; the consumption slows the expansion of the universe. The intrinsic motion of light creates space and the expansion of space - the entropy drive of light is actually visible over great distances (through our giant telescopes) as the "cosmological redshift" of distant galaxies. Space and light are linked, and it is light's entropy-energy or entropy drive hidden in space (as the implicit time or "frequency" component of its energy content) that is revealed, laid "bare", or converted to explicit time via the gravitational (or quantum mechanical) annihilation of space. (See: "The Conversion of Space to Time".)

Implicit time, hidden as "frequency" in the entropy drive of free energy, is the source for explicit time, the entropy drive of bound energy. The positive entropy drive of space becomes, by gravitational conversion/conservation, the (metrically equivalent) positive entropy drive of time. Space is the only source of temporal entropy, and by consuming space gravity ensures that it is only the entropy account of space and light which is transferred to the entropy account of time and matter. The magnitude of G is determined by the small energetic difference between the symmetric entropy drive (S) of free energy (the intrinsic motion of light as gauged by "velocity c"), and the asymmetric entropy drive (T) of bound energy (the intrinsic motion of time as gauged by "velocity T"), that is, the energy difference between implicit (S) and explicit (T) time:

$$(S) - (T) = -G.$$

It takes energy to create one-way temporal entropy from "all-way" spatial entropy, because an asymmetric, one-way temporal order must be imposed upon the symmetric, random spatial expansion. This entropy-energy cost of time is the origin of the "negative energy" characteristic of gravity and the negative sign of "-G". The magnitude of "G" gauges (determines) how much space must be annihilated (per given mass), to supply matter with its requisite historical entropy drive (Gm).

The symmetry losses (debts) of light are carried as the various conserved charges of matter, which produce forces whose conservation function (in accordance with Noether's Theorem) is to return the material system to its original state of symmetry. The conversion of mass to light by our sun is an example already cited, but others involving the complete conversion of matter to radiation are known or presumed, including matter-antimatter annihilations, proton decay, and Hawking's "quantum radiance" of black holes [5]. The gravitationally driven processes demonstrate gravity's double role as the conservator and restorer of both light's entropy drive and light's non-local distributional symmetry. (See: "The Double Conservation Role of Gravitation".)

The Phenomenon of Gravitation

The *metric* relation between space, time, and free energy (light) is gauged (regulated) by the electromagnetic energy constant c. The *entropic* relation between space, time, and bound energy (mass) is gauged by the universal gravitational constant G. The quantity of temporal entropy (the amount of time) allocated per given mass unit (m) is gauged by the strength of the universal gravitational constant: Gm. This temporal entropy requirement is satisfied via the gravitational annihilation of space, extracting a metrically equivalent time residue from the collapsed space. G is related to c through time and entropy.

The active, entropic component (the "drive") of expanding history is the intrinsic motion of time, just as the active, entropic component (the "drive") of expanding space is the intrinsic motion of light. These intrinsic motions produce the dimensional domains (history and space) of their respective energy types (bound and free electromagnetic energy). But since time is produced from space by gravitational conversion, we see that time is derivative, space is primary, and the gravitational connection to space is essentially parasitic, siphoning off the expansive energy component of space to create time and history. Time is produced at the expense of space; gravity consumes space, producing a temporal residue, and the energy of gravitation is just the entropic energy of time itself, borrowed from the intrinsic motion of light.

Gravity is weak because gravitational energy is temporal entropy-energy derived from the spatial expansion of the cosmos and used to produce the time dimension of matter and the expansion of history (historic spacetime). The relative weakness of gravity tells us that it does not take much energy to produce matter's time dimension - at least by comparison to the other forces. History is the entropic conservation domain of matter's causal information network or "matrix". The weakness of gravity is a direct consequence of the tangential or point-like connection between the "universal present moment" of matter and "bulk" historic spacetime: gravity produces only enough time to provide the temporal entropy drive for matter's tiny connection to history through the "present moment". In the case of the earth, the actual physical size of this temporal connection corresponds to the size of the "event horizon" of a black hole containing the mass of the earth - about the size of a ping-pong ball. In a black hole, gravity establishes a metric domain in which it is equivalent in strength to the other forces (g = c), and assumes all their metric, energetic, and entropic functions. (See: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".)

The invariance of charge in the service of symmetry conservation is another rationale for the tangential relationship between matter and matter's entropic conservation domain, historic spacetime. Matter, and matter's associated charges, exist only in the present moment of time, and do not participate in the entropic expansion of historic spacetime. The charges of matter, as well as the energy content of matter, are both protected from entropic enervation or dilution by the weakness of gravity and the tangential connection between matter's "present moment" and historic spacetime. Atoms simply do not age, and charge magnitudes are invariant through time. When atoms do "age", it is through the all-or-nothing quantum leap typical of the atomic realm: radioactivity, particle or proton decay.

Special Relativity also tells us that matter cannot move with the metric equivalent of "velocity c", and that therefore the time dimension must move instead, while matter simply rides the "time train". There are multiple reasons for matter's isolation in the "universal present moment", illustrating the seamless interweaving of all natural law, and raising again Einstein's question: is there any latitude in the construction of the universe? From the perspective of the "Anthropic Principle" (natural law must allow human life), the answer seems to be "no".

With matter present, the entropic march of light continues via the spatial expansion of the universe, but at a slower rate. Gravitation compensates this loss in exactly equivalent metric terms through matter's entropic temporal march and the expansion of the historic conservation domain of matter's "causal information matrix" (historic spacetime). If enough matter is present, gravity "eats up" space faster than light creates it, and the universe collapses, reversing the "Big Bang".

Gravitational energy is entropy-energy subtracted from the spatial expansion of the cosmos and transferred in metrically equivalent terms to the historic expansion of the cosmos. It is ultimately the intrinsic motion of light and the gravitational deceleration of the spatial expansion of the cosmos which funds matter's time dimension and the expansion of history. History is the temporal analog of space; historic spacetime is the entropic conservation domain of matter's causal information network or "matrix". The causal nature of historic spacetime is in itself a rationale for gravitation.

The gravitational conversion of space with its embedded drive of spatial entropy (S) (the intrinsic motion of light), to history with its embedded drive of historical entropy (T) (the intrinsic motion of time), may be symbolically represented by a "concept equation" as:

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

Because light does not produce a gravitational field, the conversion of mass to light by stars, quasars, black holes, particle and proton decay, will slowly reduce the total gravitational energy present in the universe.

Since no new matter is created to compensate this loss, the universal expansion rate will appear to slowly increase over time. Assuming that "dark matter" also obeys Noether's Theorem and the usual conservation laws, and hence is by some process also converted through time from a bound to a free energy state, the recently observed "acceleration" of the universe can be accounted for. Hence the expansive "dark energy" is just the attrition of the total gravitational force of the cosmos. If we are going to postulate the existence of "dark matter", then "Occam's Razor" suggests that "dark energy" is (at least partially) the product of "dark matter's" decay in obedience to the known conservation laws. (See: "A Spacetime Map of the Universe".)

The gravitational force we feel at the earth's surface is the flow of space that is being consumed to produce earth's time dimension. That flow is a measure of the negative energy differential between the symmetric spatial entropy drive of the free energy which created earth's mass (the intrinsic motion of light as gauged by "velocity c"), and the asymmetric temporal entropy drive of earth's bound energy (the intrinsic motion of time as gauged by "velocity T"). The temporal entropy drive "costs" more to produce than the spatial entropy drive, hence the "negative energy" character of gravity. Gravity is essentially earth's "parasitic" umbilical connection to the spatial universe, "warping" symmetric space by the creation of time and historic spacetime.

Gravity is weak only because of the tangential nature of matter's connection to "bulk" historical spacetime via the point-like "present moment". The spatial flow is never-ending because earth's intrinsic motion in time (earth's historical entropy drive) is never-ending; the time dimension moves and hence must continuously be renewed. The energy for the gravitational field is supplied by the expansive entropic drive of space (the intrinsic motion of light), resulting in the deceleration of the cosmic spatial expansion. Earth's bound energy content requires a continuous entropy drive, no less than does the free energy content of space. Time and gravity induce each other in an endless loop - *gravity is the spatial consequence of time's intrinsic motion*. The only way to get rid of gravity is to get rid of the time dimension which causality, entropy, symmetry, and energy conservation all require for matter. This can only be done by converting asymmetric matter to perfectly symmetric light, which has neither a time dimension nor the gravitational field to produce one. (See: "A Description of Gravitation".)

The Mechanism of Gravitation

We now come to the mystery surrounding the attractive principle of gravitation: space flows toward the time charge of matter, but why? It is possible that symmetric space is (vainly) trying to neutralize the dimensionally asymmetric temporal charge which has suddenly appeared in its midst; it is also possible that space is (again vainly) trying to fill the asymmetric dimension (history) opened by the time charge, analogously to air rushing into a vacuum; a third possibility is that the intrinsic motion of the entropic time charge simply pulls space after it into history, since energy conservation will not allow the connection between time and space to be broken, and if one moves, the other must follow. This third possibility is the one I favor, as it readily explains Einstein's "Equivalence Principle".

Causality in the service of energy conservation is the theoretical principle responsible for "time's arrow", while -G represents the unidirectional, contractile force. As for the acceleration of gravity, acceleration is due to the constant application of a force: in this case we have the constant, entropic flight of the time dimension into history and "bulk" historical spacetime.

This reduces the attractive principle of gravitation, and the gravitational collapse of space, to artifacts or consequences of the intrinsic motion of time. Gravity's spherically symmetric field is due to time pulling on the three spatial dimensions equally. The spatial field collapses at the center of mass, because it has to "squeeze down" into the zero-dimensional, point-like beginning of the one-dimensional time line. When the spatial field collapses to a point, a new time charge (the metric equivalent of the annihilated space) is extracted or revealed, which replaces the old, but also rushes off into history, dragging and collapsing more space behind it, continuing the endless self-feeding negentropic cycle. The gravitational collapse of space occurs at the locus of every atom or point of bound energy, summing, in the case of a planet (as Newton proved), to a total field effectively acting from the center of mass of the larger body.

As space is pulled toward a gravitational "location" or time charge (by the intrinsic motion of time, and because time and space are connected), space moves symmetrically from all possible 3-dimensional positions (time is connected symmetrically to all three spatial dimensions), and at the central time charge itself, space self-annihilates: +x cancels -x, +y cancels -y, and +z cancels -z, leaving behind a new residue of +t (time and space are metrically equivalent and interchangeable in the forward temporal direction). +t cannot cancel because there is no -t (time is one-way only, conserving causality). The new time charge replaces the old, for it is the unique character of temporal charge that it is transient (an "entropic" charge), continuously moving at "right angles" to all three spatial dimensions into the historic domain where only information can follow. Time forever renews itself by motivating the gravitational annihilation of space, thus producing the continuous one-way flow of time, the continuous (and accelerated) one-way flow of gravitation, a spherically symmetric gravitational field with a local "center of mass" where the field vanishes, and a temporal entropy which is the natural metric equivalent of the space annihilated - a tidy package indeed, all springing from the simplest and most natural interpretation of Einstein's own Equivalence Principle. Note that in this representation of gravity we have symmetric space "chasing" asymmetric time, exactly the reverse of the situation producing the intrinsic motion of light, in which symmetric space "flees" asymmetric time. This is just the difference between positive and negative spatial entropy, or implicit and explicit time. (See: "A Description of Gravity" and "Gravity Diagram No. 2").

Quantum Mechanics and Gravitation

Gravity is both a symmetry debt and an entropy debt of light, unique among the charges and their forces. This double role, which stems from gravity's conservation of the double gauge role of "velocity c", is reflected in two different mechanisms, both of which convert space to time, one at the microscopic quantum level of charge - the entropy debt, involving one-way moving time, causality, history, and energy conservation, and one at the macroscopic level of gravitational force - the symmetry debt, involving immobile mass, "location" charge, spacetime, and symmetry conservation. Time is the common factor in both roles, as time is the active principle of gravity's "location" charge.

In the microscopic, quantum mechanical transformation of free to bound energy, in the creation of particles (or simply the capture of a photon by the electron shell of an atom), the collapse of an electromagnetic wave confers a quantized time charge on a massive particle. The collapse of the spatial component of the wave leaves behind a metrically equivalent temporal residue - just as in the macroscopic gravitational process. At the microscopic level of quantum mechanics, however, we can visualize this process as a "switching" or "flipping" of the "wavelength" or spatial aspect of the moving electromagnetic wave to the "frequency" or temporal aspect of the stationary particle. This is the "primary", "particle", or quantum mechanical process for producing the time charge and the entropy-energy debt. Once this time charge is gauged and "set", the "secondary", "metric", or symmetry aspect of gravitation comes into play, the cyclic, continuous flow of space as it is pulled into the historic domain by the intrinsic motion of time, producing the macroscopic gravitational field. The continuous secondary process simply copies or reproduces the time charge set and gauged by the one-time primary process. In effect, the quantum mechanical process "kick starts" the macroscopic process by providing the initial time charge.

Finally, we can visualize the ephemeral nature of the time charge as a manifestation of its actual motion from the spatial dimensions, where it is "set" and begins, to the temporal (historic) dimension, where only information can follow. It is the intrinsic motion of the time charge which "pulls" space after it that produces the gravitational flow. *A gravitational field is the spatial consequence of the intrinsic motion of time*. The collapse of space leaves a temporal residue whose intrinsic motion pulls more space after it, in an endlessly repeating and self-feeding negentropic cycle.

The two mechanisms are distinct but both are part of the gravitational conversion of space to time, connecting the quantum-mechanical aspect of gravitational charge (the temporal entropy-energy debt of particles) to the macroscopic aspect of gravitational flow (the spatial "location" symmetry debt of mass). Both are linked by time, their common gauge c, and Noether's Theorem requiring the conservation of light's non-local metric and distributional symmetry. The gravitational charge, "location", is unique among charges in that its active principle is time. The gravitational charge is an "entropic" charge, a charge with intrinsic dimensional motion. "Location" charge not only identifies the spacetime position, magnitude, and density of asymmetric (undistributed) concentrations of mass-energy; the time component of location charge also supplies the entropy drive of bound energy. Symmetry, entropy, time, and space are all connected by gravity.

It is the concept of time as a charge ("location" charge) that allows us to connect gravitation to the other charges and forces of physics (they are all symmetry debts of light), and to quantum mechanics (the graviton is a quantum unit of negative temporal entropy or time).

It is the entropic nature of the gravitational charge which connects the quantum mechanical (charge-time-particle-entropy) and macroscopic (location-space-mass-symmetry) aspects of gravity. In turn, the double nature of the gravitational charge gives gravity a double conservation role, on the one hand conserving the entropy drive of free energy (the intrinsic motion of light) by converting it to the entropy drive of bound energy (the intrinsic motion of time), and on the other hand conserving the "non-local" metric and distributional symmetry of light by converting bound to free energy (as in our sun, the stars, and Hawking's "quantum radiance" of black holes). This duality extends backwards in a conservation chain to the double gauge role of "velocity c", which regulates both the "non-local" metric and distributional symmetry of light, and the spatial entropy drive of free energy (light's intrinsic motion). By default, gravity must conserve both gauge roles of "velocity c" if it conserves either one.

We have already noted that because of the universal energetic significance of the time dimension, the conservation role of gravity extends beyond entropy and symmetry to include causality and energy conservation. (See: "The Tetrahedron Model".)

The "graviton" or field vector of the gravitational charge is a quantum unit of (negative) temporal entropy, the transformed entropy drive or intrinsic motion of the photon, equivalent to a quantum unit of time, whose intrinsic motion in history is metrically and entropically equivalent to the photon's intrinsic motion in space. Indeed, the implicit time component in light from which the spatial photon "flees" to conserve its symmetry, is the self-same time component (but rendered explicit) which pulls space into history, producing the self-feeding gravitational field of matter. This gravitational field will also eventually conserve light's symmetry, via the conversion of bound to free energy (in stars and via Hawking's "quantum radiance" of black holes).

Black Holes and Entropy

(See: Bekenstein, J. D. *Information in the Holographic Universe*. Scientific American, August 2003, pages 58-65.)

It is helpful to look at the entire spectrum of gravitational phenomena in terms of the progressive invasion and domination of the spatial metric of light and space by the temporal metric of matter, gravity, and time. These also present a series of symmetry-conservation stages or phases.

At first, for very small bits of matter and tiny gravitational fields, the symmetric metric of light/space is hardly disturbed at all by the insignificant presence of matter/time. However, as matter accumulates into astronomically significant clumps, big enough to take on the spherical shape of its formative gravitational field (objects the size of planets), the temporal warpage of space becomes distinctly noticeable as a powerful gravitation field with a metric or inertial bias directed "downward" toward the center of mass. In such cases we see gravity paying the "entropy-interest" on matter's symmetry debt, converting space to time but nothing more. These are only "interest" payments in that the symmetry debt of the planet (mass, charge) remains unchanged despite the continued payment by the field. The next stage in massive (single) gravitational systems is that of the star, in which the gravitational field is strong enough to begin making payments on the "principle" of matter's symmetry debt, converting mass to light and actually reducing the total gravitational energy of the star as its mass is reduced. The series continues with three successive "condensed matter" states, the white dwarf, the neutron star, and finally the black hole, the end of the gravitational spectrum and the ultimate state of the temporal metric in which the electromagnetic metric of light and space are completely replaced by the gravitational metric of matter and time.

We see an interesting progression in the condensed matter series, as the gravitational force and temporal metric take over the regulatory functions of space and the electromagnetic metric. First, the electron shells of atoms are crushed unto an electron "sea", as the electromagnetic force is progressively overwhelmed. Second, the electrons are driven into the protons, forming a neutron star, as the weak force is compromised (why don't those neutron decay?); thirdly, the strong force is overtaken as the spatial metric itself collapses and proton decay converts the interior of a black hole into gravitationally bound light. We also see a successive homogenization of matter throughout the series - from the diversity of forms on planet Earth (for example), to the plasma fields of the Sun; then to the electron "sea" of the white dwarf; thence to the baryon desert of the neutron star, and finally to the "event horizon" of the black hole where only time remains. This in itself is a symmetry series of sorts, as the great diversity of matter and information is reduced to the monotony and sameness of a temporal entropy plain (the opposite pole of light's spatial entropy plain). But of course, the more significant symmetry conservation function of gravity is the conversion of bound to free energy in stars and in the latter stages of the series.

The black hole represents the extreme form of the temporal, gravitational metric of matter or bound forms of electromagnetic energy - the opposite pole of the spatial and expansive metric of light or free electromagnetic energy. But metrics, whether spatial/electromagnetic or temporal/gravitational, exist to conserve energy and symmetry, and we expect nothing less from the temporal metric, especially in its most extreme form.

During their formation in supernovas, and subsequently as matter falls into them, black holes actually release a huge amount of light, converting bound to free energy at a much higher rate than the nucleosynthetic pathway of ordinary stars - witness the quasars, supermassive black holes which outshine entire galaxies. Hence in the first instance we can regard black holes as "superstars" in their ability to convert the bound, potential, and even the relativistic energy of in-falling matter to free energy - restoring/conserving symmetry. And we know, thanks to Stephen Hawking, that back holes continue to shine - although very dimly - eventually completely converting their entire mass to light via the phenomenon of Hawking's "quantum radiance", in complete satisfaction of Noether's symmetry conservation theorem.

At the "event horizon", where g=c, in-falling matter moves at the equivalent of velocity c, recapitulating the symmetric energy state of light. Now we know that in the case of light, motion at velocity c results in the distributional symmetry of light's energy throughout its spatial conservation domain everywhere, simultaneously, and in fact we see the same symmetry conditions satisfied for matter within the boundary of the black hole. At or inside the event horizon, there is no space and time is stopped, so indeed matter is necessarily distributed inside the black hole and over the surface of the event horizon everywhere, simultaneously.

> Finally, we fully expect proton decay to be commonplace inside the black hole, because here matter is subject to the same entropic erosion of its energy as light is in space. Light is completely unified with its spatial conservation domain and fully participates in the entropic expansion of space, which rapidly vitiates its energy. Within the back hole matter is likewise fully unified with its temporal conservation domain; hence we expect the interior of a black hole to be filled with nothing but gravitationally bound light, the consequence of proton decay and the entropic erosion of matter's stored energy content by time and gravity.
>
> Hence both inside and outside, black holes are symmetry-conserving systems of the temporal metric, whether as supernovas, superstars, or quasars; via Hawking's "quantum radiance"; or through internal proton decay; - in all cases converting bound electromagnetic energy to free electromagnetic energy, via the gravitational fulfillment of Noether's symmetry conservation theorem, which is why Nature is so eager to create gravitationally bound systems, including her relentless pursuit of black holes.

According to a theorem by Bekenstein and Hawking, the surface area of a black hole is proportional to its entropy [5], [8]. The surface of a black hole is its "event horizon", the location at which space finally is moving fast enough - equivalently to the intrinsic motion of light - to "catch" and "neutralize" time, causing light and space to vanish and time to "stand still". Light, space, time, and gravity all move at velocity c at the event horizon. Temporal entropy becomes visible (again, through our giant telescopes) as the gravitational red shift of condensed matter (neutron stars), and in the even more extreme case of black holes, takes the form of the "event horizon". The surface expanse of the black hole demonstrates that time is a dimensional reality (time is not simply a human "mental construct"), and constitutes the physical demonstration and proof that gravity converts space and the drive of spatial entropy into time and the drive of historical entropy. The theoretical, formal, or mathematical proof is of course provided by Hawking and Bekenstein. (Observational evidence for the existence of black holes is by now beyond dispute. See, for one example, *Sky and Telescope* April 2005 page 43.)

As the mass of an object increases, its increasing temporal entropy requirement is supplied by a greater spatial flow - either a stronger or larger (or both) gravitational field. But in the limiting case of the black hole, a stronger field is not possible in terms of greater acceleration, because space is already moving at its maximum (velocity c), so a larger field, expressed in terms of a larger surface area, is the only accommodation available for the additional entropy needs of any new mass inputs to the system. The situation is analogous to the flow of water through a pipe: if the water flow is already at a theoretical maximum of velocity and pressure, the only way to increase the flow is to increase the cross-sectional area of the pipe.

Usually we think of gravitation as converging to a central dimensionless point - the center of mass, the point-like beginning of the time line, at which the in-flowing spatial dimensions symmetrically annihilate each other, leaving the time-charge residue. The black hole surface area is the expansion of this spatially dimensionless central point to accommodate a greater gravitational flow. This surface is still dimensionless in that there is no spatial volume present - only a "black hole" of time which displaces ordinary space somewhat (but not exactly) as a ship displaces water.

Since time is matter's entropy drive, the surface area of the black hole also represents the absolute "size" of the time dimension associated with the mass of the black hole. Hence if the mass of a black hole doubles, its surface area (not its volume) must also double. Black holes are therefore somewhat larger than we might otherwise suppose (this is where the ship displacement analogy fails). (Reader take note: this result is controversial.)

Just as we can think of a rock as light's symmetric energy transformed to asymmetric mass, brought to rest, and made visible, so we can think of a black hole's surface area as light's symmetric entropy drive transformed to asymmetric time, brought to rest, and made visible. The surface area or event horizon of a black hole is a visible "rock" formed of time - the asymmetric temporal entropy drive of bound energy.

The "black hole" condition is just that in which spatial and temporal entropy drives are not only metrically equivalent, they are fully physically equivalent in strength. At the "event horizon" of a black hole, g = c, time stands still and meter sticks shrink to nothing (the extreme case of the co-variance of space with time). If the mass of the earth were compressed to the condition of g = c or a "black hole", the earth's event horizon would only be about the size of a ping-pong ball! The surface area of this ball = the absolute size of the time dimension or temporal entropy drive of the earth's entire "rest mass", as translated into the terms of an equivalent spatial entropy drive (g = c). This illustrates dramatically just how small the temporal entropy drive of bound energy really is - and how relatively little spatial entropy drive is required to create it - which is why we find gravity to be so weak, comparatively. The gravity we feel on earth's surface is the spatial pull caused by the intrinsic motion of that same time dimension, in effect, the tiny "black hole" at the gravitational center of the earth, but the surface area of that "ping-pong ball", and its associated gravitational force, is diluted over the radius and surface area of the entire earth.

The time dimension exists at right angles to all three spatial dimensions. The black hole is the central point of intersection between space and time, enormously magnified so that their tangential point of contact becomes visible.

In the black hole, where space becomes time, we see demonstrated the fact that time moves with a velocity that is the metric equivalent of c. We also see how small is the contact point between the spatial and temporal dimensions, which is equivalent to the tangential contact point between matter's "universal present moment" and historic spacetime. In contrast, light completely occupies its entropic domain, space. Light and space are coextensive, but matter and history are not. Gravity is weak because matter's tangential point of contact between the "present moment" and its entropic conservation domain, historic spacetime, is so small. This is similar to the argument made by P. A. M. Dirac when he compared the radius of the universe to the radius of an electron, observing this was in the same proportion as the strength of the electromagnetic field to the strength of gravity. (The fact that this contact point is greater than zero means that the temporal entropy drive of matter will actually have a very small vitiating effect upon atoms, perhaps as realized through "proton decay".)

On this view, we would expect gravity to be stronger if the unit of time (the "tangential touch") were greater - which is exactly what General Relativity predicts. Time slows down (seconds become of longer duration) in a gravitational field, and time actually stops at the event horizon of a black hole, where the "present moment" becomes the "eternal now", the tangential point of contact between matter and the temporal dimension becomes infinitely enlarged, and g = c. For a further discussion of the weakness of gravity, see: "Proton Decay and the 'Heat Death' of the Universe".

It is likely that proton decay is commonplace in black holes; indeed, this may be one of the "reasons" (in addition to Hawking's "quantum radiance") why gravity is so keen to produce them - proton decay is one way to fulfill the mandate of Noether's Theorem to return bound to free energy. If so, then a black hole may be nothing less than a gravitationally bound state of light, light "transformed to rest", a "dark crystal" of light. This would solve the problem of the infinite compressibility of matter at the central singularity, since there is no limit upon the quantum mechanical superposition of photons. For an explanation of gravitationally induced proton decay, see: "Symmetry Principles of the Unified Field Theory".

> At the "event horizon" of a black hole, both clocks and light come to a halt, as the electromagnetic metric is completely replaced by the gravitational metric. Within the event

horizon, all former functions of the electromagnetic metric are either defunct or performed by the gravitational metric, including those of the the binding forces between particles. Also absent are the primordial entropy drives of space and history, the intrinsic motions of light and time. Hence the black hole is just that physical environment in which entropy, in its usual electromagnetic expressions, does not exist, and hence no change is possible as we ordinarily experience it. But gravitation is also a form of (negative) entropy, and indeed we find, just at the boundary between the electromagnetic and gravitational domains, entropy operating to convert the mass of the black hole entirely to light - via the mechanism of "Hawking radiation". This is the ultimate expression of Noether's symmetry conservation theorem, the complete gravitational conversion of bound to free energy, definitively revealing the final conservation rationale for gravitation, and by extension, for time as well.

For more on gravity and entropy see: "A Description of Gravitation"; and "Spatial vs Temporal Entropy". For a discussion of the interaction between gravitation, negative entropy, and biology, see: "Newton, Darwin, and the Origin and Abundance of Life in the Universe".

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Links:

Unified Field Theory

Section I: Unification

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