Gravity, Entropy, and Thermodynamics: Part II
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John A. Gowan
home page
E-mail: johngowan@earthlink.net (or) jag8@cornell.edu

Gravity is Matter's Memory it Once was Light

Part II - Return to Part I

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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, including 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 its spatial conservation domain?

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, nor light's purely spatial conservation domain. Nevertheless, like every form of energy, matter must have an entropy drive and conservation domain appropriate for its energy type. 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".) Matter's conservation domain is historic spacetime, including the information network or web of matter's time-dependent and temporally linked "causal matrix".

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 and historic conservation domain; 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 mass and an 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 (atomic matter). 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 and an entropic (historic) conservation domain, 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 atomic, immobile forms of bound energy break 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 entropic 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 light-symmetry. The conversion of mass to light by stars and quasars are examples 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 (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".)

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 energy content of matter is protected from entropic enervation or dilution by the weakness of gravity and the tangential connection between matter's "present moment" and historic spacetime. Atoms typically do not age ("diamonds are forever"); when atoms do "age", it is through the all-or-nothing quantum leaps typical of radioactivity: particle or proton decay. The charges of matter are symmetry debts, not energy debts as is atomic mass; charges are therefore immune to the effects of either entropy or gravity.

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 for two reasons: 1) the tiny energetic difference between implicit and explicit time; 2) 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 stars, quasars, 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 (in our Cosmos of mixed free and bound electromagnetic energy), 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 non-local distributional symmetry is the self-same *explicit* time component 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, quasars, 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.)
Scharf, C. *Gravity's Engines* Scientific American/Farrar, Straus and Giroux 2012 (book)
Science vol. 337 3 Aug., 2012 pp. 536 - 547: special section on black holes.

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 (celestial 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.

Black holes present a mass series uniquely their own, from (hypothetical) mini-holes perhaps produced during the "Big Bang", to stellar-mass holes of various sizes, and finally to million- and billion-solar mass holes embedded in the centers of (apparently) every large galaxy. Such central, super-massive black holes apparently play a significant role in the evolution of galactic form and star formation. (See: Scharf, C. *Gravity's Engines* Scientific American/Farrar, Straus and Giroux 2012 (this is a book).)

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 (quasars and "Hawking Radiation").

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 gravitational potential energy at a much higher percentage of the rest mass of in-falling particles than is possible in the fusion process of the nucleosynthetic pathway of ordinary stars (witness the quasars, supermassive black holes which outshine entire galaxies). These are recent findings, so the significance of black holes with regard to the conversion of mass to light on cosmic scales may have been greatly underestimated in the past. Hence in the first instance we can regard black holes as "superstars" in their ability to convert the potential gravitational energy of in-falling matter to free energy - restoring/conserving light-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. We know in the case of light that 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 equivalent 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 the gravitational metric of matter.

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". (As the extreme example of the co-variance of space with time ("Lorentz Invariance"), "clocks stop" because seconds become "stretched out" to infinity, and consequently meter sticks must become correspondingly short.) 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 (light's intrinsic motion) into time and the drive of historical entropy (time's intrinsic motion). 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 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 (for one reason) 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" and/or "Hawking Radiation".)

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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