Section II: Introduction to Gravitation

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home page

Papers: "A Description of Gravitation";
"Gravity, Entropy, and Thermodynamics"

Table of Contents:

Abstract
Introduction
The Symmetric "Non-Local" State of Light
"Location" Charge
Entropy and Gravity
Local Gauge Symmetry
Quantum Relations
The Intrinsic Motion of Light
The Magnitude of "G"
Black Holes
Why Gravity is so Weak
Links

Abstract

Gravity plays two primary conservation roles in nature: 1) energy conservation (at all gravitational field strengths) via the creation of bound energy's (matter's) time or historical dimension and temporal entropy drive; 2) symmetry conservation (at higher gravitational field strengths) via the conversion of bound to free energy (mass to light) in stars and related astrophysical processes, and ultimately, via Hawking's "quantum radiance" of black holes.

The relationship of gravity to the other forces is through "Noether's Theorem" of symmetry conservation: all charges and forces originate as symmetry debs of light. The gravitational "location" charge of mass (Gm), whose active principle is time, represents the symmetry debt arising from the (lost) "non-local" distributional symmetry of free energy (which creates every form of bound energy: hv = mcc).

Gravity pays the entropy-interest on the symmetry debt of matter by creating a time dimension for bound energy in which charge conservation can have an historical expression and causal significance; gravity pays the energy-principle on the symmetry debt of matter by converting mass to light (in stars and related astrophysical processes). The first reaction causes a deceleration of the expansion of the Cosmos, while the second causes an acceleration (as recently observed).

Introduction

The subject of gravitation is of course central to any attempt at force unification; the well known standoff between quantum mechanics and relativity theory centers on the inability of "establishment" physics (or the "standard model") to produce a satisfactory theory of quantum gravity, or any theory that integrates gravity with the other forces of physics (electromagnetic, strong, and weak).

There has always been an element of mystery surrounding gravitation - what is gravity and why does such a dimension-warping force exist? What is the role of gravity in the economy of natural law - what is the conservation reason for the existence of this force? Why is gravity so weak? These are among the questions concerning gravity which neither Newton nor Einstein (nor anyone since) has answered satisfactorily.

The unification theory presented in these papers is nevertheless built around the central question of why gravitation exists as a force in Nature, why it must exist, what is the conservation role of gravity? Newton and Einstein have figured out the "how" and the quantitative mathematical representation of gravitation; I set out, many years ago now, to figure out the "why". (I assume in these papers that Einstein's mathematical representation of gravitation, minus the cosmological constant, is essentially correct. However, I do not agree that light, moving freely in the vacuum of spacetime, produces a gravitational field.)

Einstein had tried to unify the long-range "spacetime forces", gravity and electromagnetism, but without success. In his day the short-range "particle forces", the strong and weak forces, were essentially unknown. A fully unified theory had no chance of being developed until the two particle forces were better known, long after Einstein's death. In the light of present knowledge, however, we can have a more reasonable hope of achieving unification.

Chronologically, the first (and most important) rung on the ladder of (my personal) understanding of gravitational unification consisted of my introduction to "Noether's Theorem", which essentially states that the symmetries of light (and of the spatial metric which light creates) must be conserved. I realized that *the charges of matter are the symmetry debts of light,* that is, the conserved charges (and spin) of particles - charge conservation - is just symmetry conservation. This is the simple, overarching principle which unifies gravity with the other forces of physics. Noether's Theorem enforced in the "real" (rather than the theoretical) world is otherwise known as "charge conservation". The "inertial" forces of spacetime, including gravitation, are the corresponding "metric" or dimensional examples of Noether's Theorem enforced. Einstein had tackled the gravitation problem (with resounding success) from the inertial, dimensional, or metric point of view. Perhaps something in addition could be gained by looking at the gravitational question from the perspective of particles and charges - completing, as it were, the particle-wave analysis of the force.

If gravity represented the conservation force associated with a symmetry debt of light (if gravity, like the other forces, was produced by a "charge"), then it would fall under the conservation umbrella of Noether's theorem and could be treated like any other charge of matter. Also, by treating gravity as one of the quantized charges of matter, one automatically had a leg up on the problem of joining quantum mechanics and relativity. The immediate question, therefore, was: what symmetry of light was gravity conserving?

The Symmetric "Non-Local" Energy State of Light

I soon realized that indeed light did have a symmetry which was broken during the conversion of free to bound energy that looked as if it might be the cause of the gravitational "charge" or symmetry debt. This symmetry is the "non-local" equitable distribution of light's energy, everywhere in spacetime, simultaneously. This distributional symmetry of light's energy comes about because of light's intrinsic motion and "non-local" character (gauged by "velocity c") - as discovered by Einstein. Light's position in spacetime cannot be localized or specified because light has no time dimension and no "x" spatial dimension in the direction of propagation. Lacking two dimensions, it is impossible to specify light's position in either 3 or 4 dimensional space or spacetime. Since neither time nor distance exists for light, yet light has intrinsic motion, light has essentially forever to go nowhere (whatever the

actual magnitude of "velocity c" might be); hence we can say that in free flight in its own reference frame (moving freely in the vacuum of space at velocity c), light is everywhere within its conservation domain of spacetime simultaneously (light is "non-local").

Einstein characterized this spatially symmetric condition of light's "non-local" energy state through his mathematical formula for the "Interval" (the "Interval" is an invariant measure of spacetime): light's "Interval" equals zero. When I realized that "velocity c" was not usefully conceived as an ordinary (nor even as a "non-ordinary") velocity, but was instead a "gauge" or regulator of energetic metric symmetry which vanished (suppressed) time and distance - and that Noether's theorem required such symmetries to be conserved - I knew that the combination of Einstein's "Interval" and Noether's Theorem gave me the formal basis for understanding gravitation as a conserved charge or symmetry debt of light. In the gravitational case, the lost or broken symmetry is light's "non-local" energy state and the lost symmetric distribution of light's energy throughout space. The distributional symmetry of light's energy is lost when free energy is converted to immobile bound energy whose concentrated "rest mass" ($E = mcc$) has no intrinsic spatial motion.

The fact that the metric "warpage" or "curvature" of a gravitational field ($-Gm$) identifies the spacetime position of the immobile lump of bound energy (m), and also reflects the quantity and density of mass, in other words, the concentration of bound energy at a particular spacetime locus, was proof to me that this force behaved exactly as a symmetry debt or charge should if it was recording, as hypothesized, the (broken) symmetry of the equitable spatial distribution of the energy of light. Gravity was telling the conservation domain of spacetime in the universal, energetic language of inertial or metric asymmetry (dimensional force) exactly where, how large, and how intense was light's distributional symmetry debt (or equivalently, matter's distributional symmetry violation) as represented by the location, quantity, and density of the immobile lump of bound energy. Finally, the light of the Sun bore witness to the fact that gravity was acting, exactly according to the expectations of my hypothesis, to "pay off" this symmetry debt by converting mass back to symmetrically distributed free energy. Hawking's "quantum radiance" of black holes carries the gravitational conversion of bound to free energy to completion - which is one reason why Hawking's result is so important.

"Location" Charge

I named this gravitational charge "location", and wrote my first paper on gravitation. This was the year 1980. My father, the late Prof. John C. Gowan, actually published a version of this early paper in his book "Enveloped in Glory" in 1982.

While the "location" charge of gravitation remains to this day as the essential "first rung" in my understanding of gravitation (gravity as the symmetry debt of the "non-local" distribution of light's energy), it was only many years later that I climbed to the next rung of understanding this complex force. According to my records (which are in most other respects lamentably incomplete), it was not until November of 1997 (17 years later - remember this is a hobby I pursued while I worked a full-time job at Cornell, built a house for my mother, and raised a family of 3 boys with my wife) that I took the next step, realizing that gravity was creating the time dimension of matter by the annihilation of space. Gravity, I finally understood, was quite literally converting space into time, and time itself was the active principle of the gravitational "location" charge. Hence the time quantum or charge is the connection between Quantum Mechanics and General Relativity - *a graviton is a quantum unit of time, metrically equivalent to a quantum unit of negative spatial entropy*.

In November of the following year, 1998, I climbed another rung and realized that time and gravitation actually induce each other in an endless cycle - much as do the electric and magnetic

fields of light, but via quite a different mechanism. The intrinsic motion of time pulls space after it into the point-like beginning of the one-dimensional time line situated at the center of mass; there space self annihilates, + x canceling - x and so on, but leaving a +T temporal residue, the metric equivalent of the annihilated space, which cannot cancel since time being one-way, there is no -T. The intrinsic motion of the new time charge immediately marches down the time line into the historic conservation domain of information and matter's "causal matrix" (historic spacetime), pulling more space after it and causing the collapsing accelerated flow of spacetime we recognize as a gravitational field.

The historic domain is at right angles to all three spatial dimensions; time is one-way because time protects causality and thereby energy conservation; the gravitational field is spherically symmetric because time couples equally to all three spatial dimensions; the field accelerates due to the constant application of a force (the intrinsic motion of time), and vanishes at the center of mass where the spatial metric self-annihilates. *A gravitational field is the spatial consequence of the intrinsic motion of time*. This mechanism is perfectly in agreement with Einstein's "Equivalence Principle", the collapsing, accelerated flow of spacetime being the indistinguishable equivalent of a static "warped" or "curved" metric field: spacetime accelerating through us is the "reciprocal equivalent" of our accelerating through spacetime. This is the macroscopic qualitative mechanism, but not yet the whole "why" of gravitation.

In terms of the present theory, we can now formulate the analogy between gravitation and electromagnetism which so intrigued Einstein: As magnetism is the invisible, spatially projective, electrically active ("electro-motive") force of the loadstone, so gravity is the invisible, spatially projective, dimensionally active ("inertio-motive") force of the ordinary rock. In the case of magnetism, we trace the force back to the moving (and aligned) electric charges of atoms in the loadstone; in the case of gravity, we trace the force back to the moving (and one-way) temporal charges of bound energy in the rock. A moving electric charge creates a magnetic field; a moving temporal charge creates a gravitational field. In both cases the field is produced at right angles to the current. The relation is reciprocal as well: moving magnetic and spatial (gravitational) fields create electric and temporal currents. Finally, gravity and time induce each other endlessly, as do the electric and magnetic field components of light's wave form. Both time and magnetism represent local gauge symmetry "currents" of their respective forces, protecting the invariance of energy conservation, causality, and electric charge.

More to the Story: Entropy and Gravitation

(See: "Spatial vs Temporal Entropy")

It was while driving to work one fine spring day in 1999 that I climbed another rung in my personal understanding of the "why" of gravitation, as the connection between gravity and entropy finally dawned on me. Gravity must be conserving the entropy of the "Universe of light", the entropy drive of free energy, the expansive principle of space, the intrinsic motion of light as gauged (regulated) by "velocity c". By July 1999 I had written the first version of the "Entropy, Gravitation, and Thermodynamics" paper. In November of 1999, I submitted the paper to the Archives of Physics (an electronic archive of physics papers, originally at Los Alamos, but now at Olin Library, Cornell University). (The archive paper has been updated many times since, but the most recent version will always be found on my public website.)

"Velocity c" is the gauge (regulator) of light's non-local, spatial, symmetric energy state, light's spatial, inertial, metric, and the gauge of light's spatial entropy drive (the intrinsic motion of light). On the one hand, "c" regulates the metric symmetry of space, suppressing the asymmetric time dimension, and maintaining light's "non-local" energy state, while on the other hand "c" regulates the

creation, expansion, and cooling of light's spatial conservation domain. By the summer of 2002 I was writing papers on "velocity c" and "velocity T" as the entropy gauges of free and bound energy, and on the entropic significance of their metrically equivalent and effectively infinite velocities. To fulfill their entropy functions, both c and T must represent effectively "infinite" velocities as a guarantee against any violations of causality or energy conservation (by fast spaceship or "time machine").

By the summer of 2003 I understood the relation between entropy and symmetry in the double role of the free energy gauge "velocity c" regulating light's intrinsic motion, and the consequent double conservation role of gravity as the carrier of the symmetry/entropy debt of light's lost "non-local" energy state. (See: "The Double Conservation Role of Gravity"). The relation between light's non-locality, metric symmetry, and lack of a time dimension meant that light is acausal. Light is non-local, atemporal, and acausal. The temporal sequence of cause and effect is meaningless to an energy form which has no time dimension. Light has no gravitational field, nor the time charge which could produce one. But matter is local, temporal, and causal, with a gravitational field produced by the intrinsic and self-renewing motion of matter's time charge. The active principle of the gravitational "location" charge is time itself, both identifying the 4-dimensional position of bound energy (recognizing light's symmetry debt), and due to time's intrinsic motion, serving as matter's entropy drive (recognizing light's entropy debt). (See: "Does Light Produce a Gravitational Field?")

Hence the ultimate reason for the existence of gravitation is a twofold conservation linkage (the consequence of conserving the double gauge role of velocity c): 1) the conservation of light's non-local distributional symmetry or symmetric energy state; 2) the establishment and maintenance of matter's entropy drive (time) and historic "causal matrix" (historic spacetime). The gravitational creation of time from space can also be seen as the conservation of light's entropy drive - the conversion of light's intrinsic motion into time's intrinsic motion. This double conservation role is accomplished through the double role of gravity's entropic time charge. Time is the active principle of gravity's "location" charge, both identifying the 4-D spatial coordinate position of asymmetrically distributed immobile mass, and simultaneously establishing the entropy drive of matter, the intrinsic motion of bound energy's time dimension (see: " The Time Train"). The conservation of energy and causality are of course also served by the gravitational creation of matter's time dimension.

The final (to date - Dec. 2008) understanding is that the intrinsic motion of time and gravitation produces the historic conservation domain of information (historic spacetime), which links today with yesterday and space with time, a linkage which is essential to upholding the reality of the "Universal Present Moment". The latter is the real effect of and necessity for matter's historic "causal matrix" - the continuum of spacetime. This last bit of understanding - that gravity produces and maintains the necessary historic/energetic connection between past and present and space and time - creating the historic continuum of spacetime - is simply the latest step up the rung in understanding the conservation role of this most complex and paradoxical of the four forces of physics. Gravity both creates and is created by the intrinsic motion of time. (See also: "A Spacetime Map of the Universe".)

Local Gauge Symmetry

The formulation of gravity as a "local gauge symmetry" constitutes yet another advance in our understanding of this primal conservation force (Nov. 2006). We can now formulate a (somewhat technical) statement of gravity's role which accommodates the "Standard Model" of "establishment" physics:

> The 1st law of thermodynamics, energy conservation, can be regarded as the primary role of gravitation, with the conservation of entropy, causality, and symmetry as corollaries, since the role of the spacetime metric is first and foremost to conserve energy. The action

of gravitation converts a global electromagnetic metric of space, light, and absolute motion gauged by "c", to a local gravitational metric of time, matter, and relative motion gauged by "G". Time or temporal entropy can be regarded as a "local" form of entropy drive, distilled from the "global" entropy drive of light (by the gravitational annihilation of space and the extraction of a temporal residue). Time is the local compensating component of the gravitational field vector (spacetime) - equivalently, the local gauge symmetry "current" - protecting the invariance of the "Interval", causality, and "velocity c", accomplishing energy conservation despite the variable and relative motions of matter, or a variable gravitational metric. To this end, time itself must be flexible and interchangeable with space (as per Special and General Relativity - "Lorentz invariance"). In this regard, time is the functional analog of the magnetic component of the electromagnetic field. (See: "Global vs Local Gauge Symmetry and Gravitation".)

Quantum Relations

(See: "The Conversion of Space to Time")

Time and gravity are the microscopic (quantum mechanical - particle/charge/temporal/entropic) and macroscopic (general relativistic - mass/location/spatial/symmetric) aspects of the same force. The unification of gravity with quantum mechanics subsists in the unification of gravity with time. *Gravity is the spatial consequence of the intrinsic motion of time*. Time is the active principle of the gravitational "location" charge. It is the entropic nature of the gravitational charge that distinguishes gravitation from the other forces and their charges: the latter represent symmetry debts only. Gravitation carries both a symmetry and an entropy debt of light, the consequence of the fact that gravity conserves both aspects of the double regulatory role of "velocity c", which gauges both the "non-local" symmetric energy state of light and the entropy drive of light (light's spatially expansive intrinsic motion). In conserving light's (broken) non-local distributional symmetry, gravitation automatically conserves both the symmetric and entropic metric gauge functions of c. Hence in the Sun, gravitation is both creating the Sun's time dimension by converting space into time, and simultaneously reversing this reaction by converting bound energy (mass) into light. (See: " Spatial vs Temporal Entropy".)

One of several rationales for gravitation (in addition to indicating immobile matter's asymmetric spatial distribution), is the causal nature of bound energy, which requires a temporal sequence to regulate its energy accounts. This temporal sequence also serves as bound energy's entropy drive, which is the metric equivalent of velocity c, the latter gauging the entropy drive of free energy. "Velocity T" and "velocity c" gauge the entropy drives which service the opposite sides of the electromagnetic "entropy coin" for matter and light (bound and free electromagnetic energy) (see: "Gravity Diagram No. 2"). G (the universal gravitational constant) is the metric conversion/conservation gauge and force acting between the two entropy drives. c is the regulator of the metric equivalence between space, time, and light; G is the regulator of the entropic equivalence between space, time, and mass. Both forms of entropy drive (the intrinsic motions of light and time) create dimensional conservation domains for their energy types (space and history), in which energy can exist, be used and transformed, but nevertheless be conserved. It is the effectively "infinite" velocity of both c and T which prevents the abuse of energy while it is being used, and also seals the borders of space and history against causality violations via fast space ship or "time machine". Gravitation also seals the borders of spacetime via the "event horizon" and central "singularity" of black holes. T, c, and G are all entropy gauges which both create and protect dimensional conservation domains: history, space, and spacetime. The creation of dimensional conservation domains via "infinitely" fast intrinsic/entropic motions is the connection between the first and second laws of thermodynamics. (See: "The Tetrahedron Model".)

The Intrinsic Motion of Light

The intrinsic motion of light is caused by the symmetric spatial component ("wavelength") of an electromagnetic wave "fleeing" the asymmetric temporal component ("frequency") - the latter is an internal property of light's own nature (frequency multiplied by wavelength = c). Only by moving constantly at velocity c can the symmetric wavelength component of light suppress the asymmetric temporal component of light to an "implicit" state - light has no time dimension, yet it has a "frequency". When light is brought to rest and becomes bound energy, the implicit time component becomes explicit, serving as matter's temporal entropy drive. The explicit time dimension of matter marches off into the historic domain, dragging space after it, and so causes the macroscopic gravitational field. The entropic time charge of gravitation is thus the connection between gravity and quantum mechanics, realized through the switch of the temporal component of the electromagnetic wave from implicit to explicit, 2-dimensional to 4-dimensional. This simple switch is the whole difference between the expansion of space as driven by the intrinsic motion of light, and the collapse of space as driven by the intrinsic motion of time and gravity - the difference between positive and negative spatial entropy, or implicit vs explicit time (see: "The Conversion of Space to Time").

The Magnitude of "G"

The magnitude of G is determined by the small energy difference between the symmetric spatial entropy drive (S) of light (the intrinsic motion of light, as gauged by "velocity c"), and the asymmetric temporal entropy drive (T) of matter (the intrinsic motion of matter's time dimension, as gauged by "velocity T"):

$$S - T = -G$$

This is equivalent to the small energy difference between implicit (S) and explicit (T) time. (See: "Gravity Diagram No. 2".)

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 notion of the gravitational conversion of space and the drive of spatial entropy (S) to time and the drive of temporal entropy (T), can be symbolically represented by a "concept equation" as:

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

The time element which is implicit in the photon and causes the intrinsic motion of light (the entropy drive of free energy), is the very same time element which becomes explicit in mass or matter, causing the intrinsic motion of time (the entropy drive of bound energy). The small energetic difference between the symmetric spatial form (S) and the asymmetric temporal form (T) of the entropy drive determines the magnitude of G: S - T = -G. (Energy must be borrowed (from space) to produce an asymmetric entropy drive from a symmetric one, hence G is negative.) Finally, this entropy-energy, like any energy, must be conserved, and how else could this conservation be accomplished except by completing the gravitational loop between the spatial and temporal entropy drives - decelerating the expansion of the entire Cosmos in consequence? The historical expansion of the cosmos is funded by the gravitational deceleration of the spatial expansion of the cosmos. This is physically accomplished by the gravitational annihilation and conversion of space into metrically equivalent temporal units.

When mass is converted to light in stars, the total gravitational energy of the Cosmos is reduced, and the expansion increases again in consequence - as recently observed.

Black Holes

Black holes are the physical evidence and demonstration that gravity creates time from space. The "event horizon" of a black hole is the "frozen" entropy of light, light's intrinsic motion converted to time and brought to rest (the Bekenstein-Hawking theorem), just as the mass of a stone is the "frozen" energy of light converted to a bound form and brought to rest. Hawking's "quantum radiance" of black holes is the ultimate expression of Noether's Theorem fulfilled (in the case of the gravitational symmetry/entropy debt), confirming that only in the black hole is gravity's conservation quest totally realized. With the complete evaporation of the black hole via "quantum radiance", the mass and entropy of asymmetric matter are all converted to its original symmetric form (light), and the gravitational field that was associated with the bound energy of the hole vanishes, its conservation work finally accomplished. (See: "Entropy, Gravitation, and Thermodynamics".)

Why Gravity is so Weak

Gravity is weak because mass is connected to its entropic conservation domain of historic spacetime only by the tangential point of the "present moment" (time is at right angles to all three spatial dimensions). Gravity creates only enough time to provide the temporal entropy drive for this point-like tangential connection between matter and its historic conservation domain. The size of this connection for the entire mass of the Earth is approximately the size of a ping-pong ball - the size of a black hole's "event horizon" containing Earth's mass. For more on this topic, see: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".

Links:

Unified Field Theory

- Section I: Introduction to Unification
- Section X: Introduction to Conservation
- Section IX: Symmetry: Noether`s Theorem and Einstein's "Interval"
- Section XIV: Causality
- Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part I
- Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 2
- A Short Course in the Unified Field Theory
- Principles of the Unified Field Theory: A Tetrahedral Model
- (Postscript and Commentary on paper above)
- The Tetrahedron Model in the Context of a Complete Conservation Cycle
- Synopsis of the Unification Theory: The System of Spacetime
- Synopsis of the Unification Theory: The System of Matter
- Light and Matter: A Synopsis
- Global-Local Gauge Symmetries and the "Tetrahedron Model"
- Global-Local Gauge Symmetries: Material Effects of Local Gauge Symmetries
- The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison

Gravitation

- Section II: Introduction to Gravitation
- A Description of Gravitation
- Global-Local Gauge Symmetries in Gravitation
- The Double Conservation Role of Gravitation: Entropy vs Symmetry
- About Gravity

12 Summary Points Concerning Gravitation
Extending Einstein's "Equivalence Principle"
The Conversion of Space to Time
"Dark Energy": Does Light Produce a Gravitational field?
Entropy
Section VII: Introduction to Entropy
Entropy, Gravitation, and Thermodynamics
Spatial vs Temporal Entropy
Currents of Symmetry and Entropy
The Time Train
The Halflife of Proton Decay and the 'Heat Death' of the Cosmos
Gravity Diagrams
A New Gravity Diagram
The Gravity Diagram
The Three Entropies: Intrinsic Motions of Gravity, Time, and Light
The Tetrahedron Model (complete version)
home page
sect2.html