Introduction to Entropy: "Intrinsic Dimensional Motion"

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John A. Gowan
home page

Papers (see also):

The Function and Energetics of Entropy
Section 2: Introduction to Gravitation
Gravitation, Entropy, and Thermodynamics
Spatial vs Temporal Entropy
The Tetrahedron Model

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Abstract

Entropy is a corollary of energy conservation. Entropy exists to ensure energy conservation and prevent the abuse and misuse of energy. Because of entropy, we are allowed to use and transform energy. Without entropy, transformation of energy would not be allowed by energy conservation. The function of entropy is so fundamental to energy conservation that it is built into the basic structure of energy itself. In free energy, the entropy drive is expressed as the intrinsic motion of light: creating, expanding, and cooling space, the conservation domain of light. In bound energy or matter, the entropy drive is the intrinsic motion of matter's time dimension - causing the expansion and aging of history, the conservation domain of bound energy's causal information "matrix". Time is the product of the gravitational field of mass/bound energy/matter, which annihilates space, revealing an *explicit* temporal residue, which formerly had served as the *implicit* drive of light's intrinsic motion. (See: " The Conversion of Space to Time".) Gravity is the conservation force which converts the spatial entropy drive of free energy (light's intrinsic motion), to the historical entropy drive of bound energy (time's intrinsic motion), and vice versa. (See: "The Double Conservation Role of Gravitation".)

Introduction

Gravity accomplishes the conversion and equilibration of light's spatial entropy drive to time's historical

entropy drive. The spatial expansion of the Cosmos decelerates accordingly, as a portion of its expansive energy is used to fund the expansion of matter's historical information domain. The gravitational conversion of bound energy to free energy, gravity's symmetry conservation role (as seen in the Sun and stars, etc.), reverses the entropic conversion role of gravity. In the solar conversion of mass to free energy, the temporal entropy drive of matter is reconverted to the spatial entropy drive of light. (See: "The Double Conservation Role of Gravitation".) This process reduces the total mass of the Sun/stars, etc., and therefore the total gravitational energy of the Universe, reversing as well the deceleration of the Cosmos, and thus producing the recently observed "acceleration" of the cosmic expansion. (See: "Dark Energy: Does Light Produce a Gravitational Field"?)

The "infinite" velocities of both light and time (which are metric equivalents) are completely necessary to their roles as entropy drives of their respective dimensional conservation domains, as they positively prevent the circumvention of entropy (and thereby a violation of energy conservation) via "time machine" or superluminal velocity. In black holes, gravity takes over this protective role, stopping both clocks and light, but in compensation sealing the borders of its closed entropic conservation domain via an "event horizon" and a central "singularity".

Hence we see the primordial entropy drives of free and bound energy, including their gravitational conversion force, not only creating dimensional conservation domains (space, history, black holes) for their respective energy types, but aggressively protecting the borders of those domains to prevent any violation of energy conservation. The black hole evidently represents a type of conservation domain for entropy itself, with the surface area of the black hole representing the extent of this domain (as per the Bekenstein-Hawking Theorem relating the entropy of a black hole to its surface area).

According to my (incomplete) records, the concept of entropy was first incorporated into my website as a major topic relatively late in the game, with the large paper "Gravity, Entropy, and Thermodynamics" on 12 July 1999 (submitted to the "Archives of Physics" 15 Nov. 1999). Also in 1999 the topic of "Information" appears for the first time in the title of a paper "The Information Pathway", November 1999. Whereas the concepts of energy conservation and symmetry conservation were the foundations of the developing unification theory since its inception in November 1981, almost 18 years were to pass before either Entropy or Information - the other 2 corners of the "Tetrahedron Model" - were incorporated explicitly rather than implicitly into the evolving synthesis. ("Information" was later (2005) demoted to a secondary status in favor of "Causality" (the law of cause and effect); however, the two concepts are strongly linked (as in the notion of "Karma") and share the "matter" apex in the Tetrahedron Model.)

Most people have an intuitive understanding of entropy, because like light, time, and gravity, entropy is a common force in daily life: things age, decay, and wear out; objects fall down and break, but never fall up and repair themselves; soup cools off spontaneously, but never the reverse; heat loss and inefficiency are facts of life; gambling is a losing proposition; perpetual motion machines are impossible, etc. The same energy cannot be used twice to produce the same net work; there is no "free lunch". This is just the way the world is; only the continuing energy input from our Sun and the steady biological cycle of the generations keeps us going.

The formal concept of entropy is associated with the German physicist Clausius, who announced in 1850 that: l) "The energy of the World is constant" (1st law of thermodynamics - energy conservation); 2) "The entropy of the World tends toward a maximum" (entropy always increases, the 2nd law of thermodynamics). Boltzmann (in the 1870s) introduced the concept of entropy as probability, with his famous equation $S = K \ln W$, founding the field of statistical thermodynamics. With Carnot's demonstration of the theoretical impossibility of a perpetual motion machine (1824), these ideas became the foundations of the science of thermodynamics, with contributions from many famous names in physics, including Mayer, Joule,

Helmholtz, Kelvin, Maxwell, Nearnst, Gibbs, Planck, and Einstein, among others. (See: "Spatial vs Temporal Entropy".)

Pure and Mixed Forms of Entropy

It is not the purpose of these papers to dispute, modify, or even explain, the standard and well-established versions of thermodynamic, statistical, or information entropy, which can be found in any encyclopedia or college textbook. Rather, the intent here is to enlarge the usual scope of the subject to recognize and embrace the intrinsic motions of light, time, and gravitation, as providing both the primary drives and the dimensional conservation domains within which entropy as it is commonly understood (as in "work" entropy), has its foundation, meaning, and activity.

Unless the context indicates otherwise, when I refer to "entropy" in these papers (especially in such phrases as "light and the drive of spatial entropy" or "time and the drive of 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" (in the case of "spatial entropy"); or as the intrinsic motion of time "gauged" or regulated by "velocity T" (in the case of historical or "temporal entropy"). (See: "The Tetrahedron Model".)

Entropy exists in several forms in nature, all with the same purpose: to prevent violations of energy conservation. In these papers, I distinguish between:

1) Primary or spatial entropy, the entropy of expanding and cooling space, the entropy of free electromagnetic energy, radiation, or light, whose "drive" or essential motivating dynamic is the intrinsic motion of light, as "gauged" or regulated by the universal electromagnetic constant, "velocity c". We are accustomed to think of space as static and time as dynamic, because of our own inertial stasis and the effects of scale, but space is just as dynamic as time in the entropic sense, constantly expanding and cooling due to its energy content and its entropy drive, the intrinsic motion of light. The entropic expansion of space is actually visible in our (large) telescopes as the "red shift" of all distant galaxies. (See: "A Spacetime Map of the Universe".)

2) Secondary or historical entropy, the entropy of expanding and aging history, the entropy of bound electromagnetic energy, mass, or matter, whose "drive" is the intrinsic motion of time as "gauged" or regulated by velocity c or "velocity T". Time is defined as the duration (measured by a clock) required for light to travel a given distance (measured by a meter stick) in vacuum. As Einstein has demonstrated, space and time are not independent variables, nor are their entropy drives (intrinsic motions). Space is ultimately related to the wavelength of light, and time to the frequency of light, such that frequency multiplied by wavelength = c.

One can circumvent the circularity of measuring space by time by resorting to the independent variable, "number", and (choosing a convenient "gauge" or standard frequency) count a fixed number of oscillations of light to measure a standard duration. A standard distance is then given by the space traversed by these same oscillations - since "c" is invariant. Time is derived from space by the gravitational annihilation of space (revealing a metrically equivalent temporal residue), or the quantum mechanical "collapse" of an electromagnetic wave (as when free energy is converted to bound energy). (See: " The Conversion of Space to Time".)

3) Gravitational entropy, a negative drive of spatial entropy and an entropy-converting force, creates time from space and vice versa, (driven by the intrinsic motion of matter's gravitational field, as gauged by the universal gravitational constant "velocity G"). Gravitation is the conversion force between the primordial drives of spatial and temporal entropy. Matter's gravitational field is in turn *the spatial consequence of the intrinsic motion of time:* time and gravity induce each other much as electric and magnetic fields induce

each other. Gravity is therefore related to c through T; all intrinsic (dimensional and entropic) motions are ultimately derived from or related to c. Whereas c is the gauge of the metric relation between space, time, and light (free electromagnetic energy), G is the gauge of the entropic relation between space, time, and mass (bound electromagnetic energy). G is related to c through time and entropy. (See: "Global vs Local Gauge Symmetry and Gravitation".)

4) Spatio-temporal entropy, a tertiary form of combined entropy ("ordinary" entropy), resulting from the mixture of the primary and secondary forms (producing matter in motion), conceived and formulated in two distinct treatments:

> **a)** The familiar thermal entropy (S) of "work" formulated by Clausius, manifesting as "heat" (dQ) divided by absolute temperature (T): dS = dQ/T (the entropy associated with molecular motion and kinetic energy);
>
> **b)** The statistical or probabilistic interpretation of entropy due to Boltzmann (S = K ln W, where K = Boltzmann's constant (an energy measure per degree of absolute temperature), and ln W is the natural logarithm of a probability expression), manifesting as the most probable, most symmetric, or most random molecular state (the entropy of probability with respect to the distribution of molecules and their kinetic energy, temperature, or state of excitation).
>
> The equivalence between the thermal and the probabilistic formulations of entropy is complete and can be expressed by the equation: dQ/T = K ln W. In other words, probability (at least at the molecular level) is a force in nature which can be expressed in the energetic terms of heat or calories, and therefore, "work" and entropy.
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> **c)** Information Entropy: Does the combined form of spatio-temporal entropy produce physical dimensions as does the intrinsic motion of the "primordial" pure forms? Historical spacetime is the product of the entropy drives (intrinsic motions) of light, gravity, and time, not the direct product of spatio-temporal entropy. However, spatio-temporal entropy produces (with the necessary help of gravity and evolution) the negentropic information domain of biology, which can readily be argued is a dimension in its own right, especially at the level of the abstract information systems of advanced human societies (the arts, sciences, technology, culture), or indeed, of human thought itself (imagination). If we grant that information (including life) is a type of dimension, then spatio-temporal entropy indeed produces a dimension, as do the other three entropy forms (space, history, historical spacetime). Shannon's communication entropy (1948), which follows Boltzmann's model in its mathematical formulation, would appear to be a related mixed form of spatio-temporal entropy unique to the information dimension. The information dimension is physically related to historic spacetime; both are required by the causal nature of matter. Historic spacetime is the conservation domain of information and matter's "causal matrix" (the source of consequential repercussions or "karma") Entropy in the information realm would apparently be a function of the dilution of causal information through time (as exampled in "chaos" theory).

The 1st law of thermodynamics, energy conservation, can be regarded as the primary conservation role of gravitation, with entropy, causality, and symmetry conservation as corollaries, since the role of the spacetime metric is first and foremost to conserve energy. The action of gravitation converts a "global" metric of space, light, and absolute motion gauged by c, to a "local" 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) - 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, and the variable gravitational metric. To this end, time itself must be flexible and interchangeable with space ("Lorentz Invariance", as per Special and General Relativity). In this regard, time is the functional analog of the magnetic component of the electromagnetic field. (See: "Global vs Local Gauge Symmetry and Gravitation".)

"Ordinary", "Work", or "Textbook" Entropy

The primary (spatial) and secondary (temporal) forms of entropy create dimensional conservation domains for free and bound energy, in which energy can be used, transformed, but nevertheless conserved. Gravitation connects the primary forms of the spatial and temporal entropy drives, converting one to the other, creating time from space, light from mass (in stars), and creating spacetime, the joint dimensional conservation domain of free and bound energy. Mixed, or tertiary "spatio-temporal" forms of entropy do not create conservation domains in the dimensional sense, although they do participate in the creation of life, which can be considered a type of "information dimension". Life may be viewed as a conservation domain of molecular genetic information, as distinguished from the abiotic, historic conservation domain of information created by the intrinsic motion of time (historic spacetime). By virtue of its genetic system (genes are conserved (heritable) units of molecular information), and the negentropic mechanism of Natural Selection, life produces over time the vast biotic information conservation domain of planet Earth (now including human information systems) - Lovelock's "Gaia", or Chardin's "Noosphere". (See: "The Information Pathway".)

Unlike the primary drives, or "absolute" forms of entropy (the intrinsic motions of light and time), "mixed" or "tertiary" ("spatio-temporal") entropy is a "relative" form of entropy in that it depends upon temperature differences, quantities, probabilities, and the specific characteristics of substances (specific heat, heat of fusion/crystallization, etc.). The absolute zero of temperature represents a baseline for spatio-temporal entropy which allows the calculation of "invariant" rather than relative measures of spatio-temporal entropy. This temperature baseline, nevertheless, has no meaning for velocity c, time, or gravitation (primordial rather than mixed forms of entropy). Primary and secondary forms of entropy increase only, either with respect to the expansion of space (driven by the intrinsic motion of light), history (driven by the intrinsic motion of time), or both, depending upon the gravitational tradeoff between them; spatio-temporal ("tertiary") entropy forms increase, stand still, or can actually decrease through the input of "work". Whole system analysis, however, will show that (in an expanding Universe) even spatio-temporal entropy never spontaneously deceases. Only in the collapsing phase of a gravitationally closed Universe can we find the spontaneous decrease of thermal entropy in whole systems.

Gravity and Entropy

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

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

Gravity can cause the entropy drives of time and light's intrinsic motion to slow and even stand still, as in the "event horizon" of a black hole, but only because gravity takes over both of their protective roles of "infinite" velocity, sealing the borders of spacetime against causality and energy conservation violations via the "event horizon" and "central singularity" of the black hole. While gravity can reverse the thermal aspects of the tertiary, mixed, or relative forms of entropy, it cannot simultaneously reverse both the primary and secondary forms (intrinsic motions c and T), although gravity can slow and halt them both locally in black holes, because it can replace both their intrinsic motions and protective functions (when g = c, light

and time stand still, space and particles vanish).

c, G, and T are all interrelated entropy gauges or regulators, c for free energy and the spatial entropy drive, T for bound energy and the historical entropy drive. G is the entropy conservation/conversion gauge, regulating the energetic/metric relation between the drives of spatial and temporal entropy, converting space to time, and vice versa (as in stars). In these conversions, gravitation creates spacetime, the joint dimensional conservation domain of free and bound energy. The dimensions are entropy domains created by the intrinsic dimensional motions of light and time, joined, transformed, and equilibrated by gravitation, as gauged by c, T, and G. (See: "Entropy, Gravitation, and Thermodynamics".)

The hidden connection between c and G is that gravity creates time from space, but both space and time are gauged by c. G and T are also bound together, inducing each other in an endless cycle. Hence there is a perfect triangular connection between these three intrinsic motions, or entropy gauges of nature. (See: "The Tetrahedron Model".) Furthermore, "c" gauges both the entropy drive and "non-local" symmetric energy state of free energy: the intrinsic motion of light expands and cools the Universe while vanishing time and establishing metric symmetry. Gravity conserves 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 gravity conserves the symmetry of light by converting mass to free energy - as in the stars and quasars. Finally, in Hawking's "quantum radiance" of black holes, gravity completely converts bound to free energy, conserving the symmetry of free energy and even the symmetry of entropy simultaneously - the ultimate gravitational expression of Noether's theorem of symmetry conservation. (See: "The Double Conservation Role of Gravity".)

The Bekenstein-Hawking theorem relates the entropy of a black hole to the surface area of its event horizon. The event horizon of a black hole is a time surface, where time stands still and is made visible because gravity is replacing time as fast as time moves away into history (g = c). Whereas an ordinary rock is an asymmetric form of light's energy transformed to matter, brought to rest, and made visible, the event horizon of a black hole is an asymmetric form of light's entropy transformed to time, brought to rest, and made visible. Black holes are the physical evidence that gravity converts space and the drive of spatial entropy to time and the drive of historical entropy, while Bekenstein and Hawking have provided the theoretical and mathematical description.

The common feature of the drive of spatial entropy (the intrinsic motion of light) and the drive of historical entropy (the intrinsic motion of matter's time dimension), or their combination ("spatio-temporal" entropy), is that all three refer to the decay, expansion, cooling, aging, dilution, randomization, or leveling-out of a concentration of heat, energy, information, structure, or distribution. The simple connection between entropy and symmetry is that whatever state maximizes symmetry (at a given temperature) will also maximize entropy - which is why light has the greatest symmetry and entropy of any energy form, and why "velocity c" is both the symmetry and the entropy gauge of free energy. (For a further discussion of the principles involved in the energy relations between spatial, temporal, and gravitational forms of entropy, see: " Spatial vs Temporal Entropy" and "The Function and Energetics of Entropy".)

Given the absence of antimatter and strong gravitational fields, radioactive, particle, and proton decay are the ultimate expressions of the vitiating effects of temporal entropy upon matter. For a discussion of the comparative effects of spatial vs temporal entropy, including the weakness of gravity, see: "The Half-Life of Proton Decay and the 'Heat Death' of the Cosmos".

Further Readings:

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Links:

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