

## Section 14: Causality

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**John A. Gowan**

email:

[jag8@cornell.edu](mailto:jag8@cornell.edu)

[johngowan@earthlink.net](mailto:johngowan@earthlink.net)

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### ABSTRACT

Causality as a major player in the evolving [Tetrahedron Model](#) is the most recent of all the conservation principles to come into focus. Causality has always been recognized as an important part of the theory, but it was only in March of 2005 that I decided the principle was of such major importance and carried such explanatory power and connective significance that it should actually displace the principle of "[Information](#)" as the central and primary descriptor of matter in the Tetrahedron Model and [associated diagram](#).

While "[Information](#)" is a good, necessary, and very general characterization of the fundamental significance of matter, both for the Tetrahedron Model and the Universe, it is not quite "active" enough in its meaning to successfully complement and connect to the other three conservation principles of the Tetrahedron Model. "Information" is an asymmetric energy state, whereas Energy Conservation, Entropy, and Symmetry are conservation principles. Causality is also a conservation principle, and it seamlessly connects with the other three in a profound and illuminating way, as we shall hopefully see below. Meanwhile, although "Information" is to be demoted to a secondary position in terms of activity or action among the "Tetragrammaton" of conservation laws, it obviously remains of first importance as regards the description of the significance of the system in both its particulars and its entirety. Information, in the form

of charge, is strictly conserved; in its historical form, information is subject to entropic enervation (age, decay, dispersion, dilution) but is never entirely lost. It is in fact the potent combination of Causality and Information that makes up matter's "causal matrix" within the conservation domain of historic spacetime, the "Karma" and "Akashic Record" of metaphysical systems of thought. It turns out that neither Causality nor Information has any meaning without the other (they are a mutually inclusive entangled pair - bridging the gap between Relativity Theory and Quantum Mechanics), but the linkage to the other conservation laws is clearer and stronger in the case of Casualty - due to its temporal parameter. To an explanation of this linkage I will now turn my efforts.

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### *Afterthought and Cosmology:*

Quantum mechanics is necessary because Nature (including energy itself) is quantized at the structural level of elementary particles and charges. Charges are necessary ([especially alternative identity charges](#)), if an asymmetric universe [full of information and life](#) is to manifest ([via the Higgs boson](#) and its IVBs) - from the all-symmetric Multiverse. [Our Cosmos exists in an asymmetric form](#) which nevertheless can be [conserved through time](#) (via the conservation of "symmetry debts" (= "charges")), returning eventually (via charge conservation/cancellation/annihilation) to its [symmetric energetic origin](#), light.

[Relativity is necessary](#) (as in "Einstein's Interval" and "Lorentz Invariance") for the universe to exhibit an extended (and seamless) dimensional/metric network (3 space, 1 time). Our dimensional [expressions of spatial/temporal entropy](#) (produced by [the intrinsic motions of time, light, gravity](#)), allow energy to take a massive asymmetric form ("matter" only, no "antimatter") comprised of atomic, historic information with relative motion rather than absolute motion at "velocity c". Our spacetime achieves conservation (including causality) for both free (massless light) and bound (massive atoms) forms of electromagnetic energy, simultaneously. [Time is created from space via gravitational transformation](#). The historic entropic domain of matter is therefore produced (and

subtracted from) the spatial entropic domain of light by gravitational conversion. [Black holes function as the final solution](#) to the difficult problem of symmetry conservation for "baryon number charge" (via the creation of matter-antimatter particle pairs and "Hawking Radiation").

The acceleration of the expansion of spacetime is due to universal symmetry conservation: the conversion of matter to light in all astrophysical processes (because [free light produces no gravitational field](#)). "Dark Matter" likely consists of heavy leptoquark antineutrinos, [produced during the "Big Bang"](#), which balance the "baryon number charge" of our "matter only" Cosmos. The positive electromagnetic energy content of our cosmos is exactly balanced by negative gravitational energy; charges are balanced by anticharges, both originally (by antimatter) and today (via alternative charge carriers). Our cosmos required no net energy for its creation; charges exist as a strict conservation measure (the "police" of the cosmos) required for its birth and subsequent regulation/evolution, as it begins with nothing (neither energy nor charge) in excess. [The charges of matter \(including gravity\) are symmetry debts of light \("Noether's Theorem"\)](#).

The Higgs boson and its associated IVBs (Intermediate Vector Bosons) lead the escape into asymmetric freedom from the smothering embrace of the all-symmetric Multiverse. The Higgs identifies the exact energy at which a "lawful" (charge-conserving) escape is possible, complete with electrically neutral leptoquarks and alternative identity-charge carrying antileptoquark neutrinos (the probable source of "dark matter"). The Higgs is the scientific analog of Eve's apple, opening the door to a free (contingent), but temporal and karmic, universe. The Higgs must be a massive particle to exactly reproduce this precise "escape energy", despite the enervating effects of entropy in an expanding and ageing universe.

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## **Interactions Among the 4 Conservation Principles of the [Tetrahedron Model](#)**

1) [Energy Conservation](#) regulatory interactions - all other principles

serve Energy Conservation ("first among equals"):

- a) Entropy: the creation of the conservation domains of space, history, and spacetime through the intrinsic, dimensional motions of light, time, and gravity, allowing the simultaneous use, transformation, and conservation of energy (as regulated by "velocity  $c$ " and the laws of Thermodynamics).
- b) Causality: time and raw energy conservation, including the conversion of free to bound energy (as in mass, momentum, or kinetic energy), and the [conversion of space to time by gravity](#), including the temporal sequence of cause and effect (as regulated by Special Relativity).
- c) Symmetry Conservation: charge conservation (including "spin"), and metric symmetry conservation via the inertial and gravitational forces of the metric (as regulated by Noether's Theorem).

2) Entropy (in its primordial forms: intrinsic motions  $c$ ,  $T$ ,  $G$ ) creates dimensionality: Entropy serves Energy Conservation by the creation of dimensional arenas in which energy can be simultaneously used, transformed, and conserved. The dimensions of spacetime are entropy domains.

- a) Space for free energy (created by the intrinsic motion of light as gauged by "velocity  $c$ ", expanding and cooling space).
- b) History for bound energy's causal information matrix (created by the intrinsic motion of time, as gauged by "velocity  $T$ ", the metric equivalent of  $c$ , aging and decaying matter and expanding and diluting history, the temporal analog of space).
- c) Spacetime for the mixture of light and matter (created by the intrinsic motion of gravitation, as gauged by "velocity  $G$ ", decelerating the spatial expansion of the Cosmos as it increases the temporal/historic component of spacetime. Gravity is the force which converts space and the drive of spatial entropy (the intrinsic motion of light), to time and the drive of historical entropy (the intrinsic motion of time), and vice versa (the latter in the conversion of bound to free energy in stars, etc.).

3) Symmetry Conservation serves Energy Conservation in obedience to Noether's Theorem, primarily through:

- a) Inertial forces of the spatial metric, including the intrinsic motion of light, as gauged by "velocity  $c$ ": maintaining spatial metric symmetry requires the suppression of time by velocity  $c$ , while simultaneously allowing the operation of spatial entropy (the expansion and cooling of space; "velocity  $c$ " gauges both the entropy drive and the "non-local" symmetric energy state of free energy).
- b) Suppression of the virtual particle "sea": Symmetry Conservation suppresses the devolution of light to matter by the continual annihilation of matter-antimatter virtual particle pairs, primarily via their opposite electric charges.
- c) Charge Conservation: Symmetry Conservation allows "symmetry-breaking" by the weak force during the "Big Bang" (involving the breaking of the symmetry of virtual particle-antiparticle pairs). The conversion of light to matter is permitted only because charge conservation guarantees the eventual return of bound to free energy (as via matter-antimatter annihilations, particle and proton decay, and the gravitational conversion of matter to light in stars, quasars, and the "quantum radiance" of black holes). *The charges of matter are the symmetry debts of light.*

The role of charge conservation and information is to provide a conserved (guaranteed) pathway for asymmetric matter back to the symmetric energy state of light. The role of the gravitational charge ("location") in this process is the creation of a new, 4th dimension (time) in which charge conservation has meaning (the indefinite storage of charge through time until it is repaid - usually by matter-antimatter annihilations). The energy deficit of gravitation represents the "interest" on the temporal symmetry debt of matter, which is paid via the gravitational deceleration of the spatial expansion of the Cosmos. Space and the spatial entropy drive of light is gravitationally converted to, and funds, history and the temporal entropy drive of matter.

4) Causality is the temporal, sequential ordering of energy, information, interaction, and the spacetime metric (law of cause and effect). Causality requires:

- a) Special Relativity, including "Lorentz Invariance", the invariant

"Interval", and the invariance of "velocity  $c$ ", to regulate the interactions of the relative motions of matter with the absolute motion of light. Causality is a necessary but not sufficient condition for the conversion of free energy to bound energy.

b) The one-way intrinsic, entropic motion of time as an ordering principle, including a gravitational field to create and sustain matter's time dimension (time is the active principle of gravity's "location" charge, and gravity is the spatial consequence of time's intrinsic motion); causality is one among several rationales for gravitation.

c) Charge Conservation to create and preserve information in the historic domain of spacetime (Noether's Theorem). Causality and Information are a linked pair, each implying and requiring the other.

Causality serves Energy Conservation by insuring that there is always a source for energy (causes must precede effects), an entropy drive for bound energy (time); a spacetime center for the gravitational field; and that massive objects may move and interact in space (at less than velocity  $c$ ) without violating energy conservation (momentum and kinetic energy). Finally, causality orders information just as it orders metric structure and energy flow, providing an evolutionary and developmental route as well as a gravitational pathway for the return of matter to light (for example, biology and the nucleosynthetic pathway).

### **1) The Conservation of Energy and Causality** (ordering energy and interaction)

The temporal ordering of cause and effect is the major issue here. Energy conservation demands that causes precede effects - otherwise we have energy inputs without energy sources. This obvious and simple rule, which should require no explanation, has nevertheless become muddled by apparent (and much advertised) "breaches of causality" in quantum phenomena. I will only say that these "violations" are: 1) only apparent or "virtual"; 2) never observed in massive macroscopic systems; 3) due to the well-known "non-local", a-temporal, and a-causal nature of light, including DeBroglie's "matter waves".

We live in a joint dimensional conservation domain in which 2-dimensional free electromagnetic energy (light) is mixed and interacts with 4-dimensional bound electromagnetic energy (matter). In order for light and matter to interact and yet conserve energy, some special rules must be obeyed because they are of different dimensionality and hence of different inertial status, obeying different inertial rules. A special problem applies to causality in their interactions because light has "intrinsic motion  $c$ ", an absolute and invariant spatial motion, and has no temporal motion at all (as Einstein discovered, light's "clock" is stopped), while matter's inertial status is just the reverse - matter's time dimension has "intrinsic motion  $T$ ", while matter has no (net) intrinsic spatial motion at all. Finally, light's intrinsic spatial motion is the metric equivalent of the intrinsic motion of matter's time dimension. Matter moves in time as fast as light moves in space - indeed, "time flies" (See: "[The Time Train](#)"). The metric equivalency between "velocity  $c$ " and "velocity  $T$ " is the most basic and commonplace example (nevertheless, generally unrecognized) of the accommodation between free and bound energy necessitated by energy conservation due to their different inertial and dimensional status.

But Einstein realized that more was necessary to fully accommodate the dimensional interactions of these two very different energy forms with respect to causality and hence energy conservation. To this end the theory of Special Relativity and its central feature, the invariant "Interval", is required to rescue causality from the shifting perspectives of the relative motion of matter vs the absolute motion of light. The dimensions themselves must give and take ("Lorentz Invariance"), meter sticks become shorter while seconds become longer, precisely in order to maintain causality and the invariance of velocity  $c$  and the spacetime "Interval" in massive objects/systems in relative motion. (See: "[The Paradox of the Traveling Twins](#)".)

The major connection then, between energy conservation and causality, is the ordering of cause and effect, requiring Einstein's theory of Special Relativity to sort out the dimensional interactions of light and matter in absolute vs relative motion. Einstein's most

famous formula,  $E = mc^2$ , arises from an analysis of the difference between the absolute motion of light and the relative motion of matter (kinetic energy of matter =  $1/2 mv^2$ ). Matter's causal relations must be satisfied if free energy is to be converted to bound energy.

## 2a) Causality and Entropy (ordering the metric)

The intrinsic motion of time is both the entropy drive of bound energy and its causal ordering parameter. Therefore the three entropy gauges,  $c$ ,  $T$ , and  $G$ , all have two linked functions: symmetry conservation and entropy in the cases of  $c$  and  $G$ , entropy and causality in the case of  $T$ . Light is linked by space; matter is linked by time; all are linked by gravity ([since gravity creates time from space](#)).

Causality is why the intrinsic motion of time must be linear, one-way, and the metric equivalent of velocity  $c$ . All forms of energy require an entropy drive or gauge; for free energy the entropy drive is the intrinsic motion of light, gauged as "velocity  $c$ "; for bound energy the entropy drive is the intrinsic motion of time, gauged as "velocity  $T$ ". Time is created by the gravitational annihilation of space, revealing a temporal residue which is the metric equivalent of the annihilated space. Time and gravitation induce each other endlessly: *gravity is the spatial consequence of time's intrinsic motion*.

Causality, temporal entropy, and the conservation of symmetry are all rationales for gravitation. The gravitational "location" charge, for which time is the active principle, satisfies all three needs simultaneously. (See: "[Entropy, Gravitation, and Thermodynamics](#)"). Because the gravitational production of time by the annihilation of space decelerates the spatial expansion of the Cosmos, and because this expansion is driven by the intrinsic motion of light, we see it is ultimately the entropy drive of free energy which funds the entropy drive of bound energy. The expansion of matter's historic domain ( $T$ ) takes place at the expense of light's spatial domain ( $S$ ):

$$\begin{aligned} -Gm(S) &= (T)m \\ -Gm(S) - (T)m &= 0 \end{aligned}$$

(See: "[A Description of Gravitation](#)".)

## 2b) Information and Entropy

The connection between Information and Entropy is through time and historical causality. The time component is necessary to link each piece of information (each bit) into the causal matrix of matter. Time is the entropy drive of matter and information, and creates the causal linkage of matter's information matrix or historic causal domain. Each quantum bit of information is associated with a quantum bit or link of time (like a chain link), which integrates the information bit into the general causal matrix or information field of matter. Entropy is always associated with energy, in this case bound energy, so a quantum unit of time or temporal entropy can be associated with a quantum unit of energy as well as of information. The gravitational conversion of space and the drive of spatial entropy into history and the drive of temporal entropy reaches a natural limit in the "event horizon" of a black hole where  $g = c$ . The surface area of a black hole's event horizon is proportional to its entropy, in terms of time or information (the Bekenstein-Hawking theorem).

A famous connection between Entropy and Information is between Boltzmann's formulation of statistical thermodynamic entropy (1870s), and Shannon's parallel formulation of information entropy (1949). The two are computed by the same mathematical formula and when calculated for the same degrees of freedom (the same variables) are equal. The connection between elemental time and information in the Tetrahedron Model applies equally to both types of entropy, satisfying the condition that Shannon's (or Boltzmann's) entropy is not associated with meaning or significance, which is context dependent. The meaning or significance of information, with which we are of course very much concerned, is a characteristic of higher levels of the natural hierarchy, including information in the sense of complex organizational states, such as the functioning human body or society. See: *Scientific American* Aug. 2003 p. 58-65 "[Information in the Holographic Universe](#)" by Jacob D. Bekenstein.

## 2c The Destruction of Information

Is information destroyed in a black hole? This question is debated in Leonard Susskind's recent book: "The Black Hole War" (Little, Brown, and Co., 2008). From the overview of the "Tetrahedron Model" and Noether's principle of the conservation of symmetry, it appears that information should be destroyed in a black hole. There are several reasons to think so (contrary to the conclusions of Susskind's book). First, on the premise that the universe begins as light, devolves to matter, and finally evolves and resolves to light again, conserving the original perfect symmetry of free electromagnetic energy, information must be destroyed in any physical process which returns matter (and the information which matter contains) to light. Such final symmetry-restoring (conserving) reactions and processes include: 1) (actual) matter-antimatter annihilations due to the electromagnetic force; 2) (hypothetical) proton decay due to the strong and weak nuclear forces; 3) (theoretical) "evaporation" of black holes due to "Hawking radiation" (gravitational force); 4) (possible) "Big Crunch" gravitational collapse of the cosmos.

All four processes are driven by symmetry conservation acting through the charges of the four forces of physics. *The charges of matter are the symmetry debts of light* (Noether's Theorem). Light, as a perfectly symmetrical form of energy, does not contain any charge, any time dimension, any gravitational field, nor any information. Information is necessarily an asymmetric form or configuration of energy, and hence must be destroyed with charge when charges are annihilated and material energy forms are returned to their original symmetric state, light (in obedience to Noether's Theorem). If the universe begins with light (which contains no information) and returns to light, then information must be destroyed in the process of the final return. This is the long or generalized view of information destruction during the process of symmetry conservation as visualized in the "Tetrahedron Model".

A somewhat more detailed view of these same (above) processes takes note of the fact that even though a particle or a system is swallowed by a black hole, the prior history of that particle or system

remains extant (except in the case of the "Big Crunch"). So both positions in the "black hole information war" may be correct - black holes do indeed destroy particular information systems, but those systems and the information they contain nevertheless survive in a real historical sense - if not as actual records (external to the hole), then as light visible to distant observers, and/or as influences and "karmic consequences" which propagate endlessly in causal chains and dendritic repercussions throughout spacetime.

This latter view is very similar to the "holographic boundary" vision of information conservation as put forward in Susskind's book. For example, light always travels in the "universal present moment", which forms the spacetime boundary of our universe - the outermost spatial line of the ["Spacetime Map of the Universe"](#). The boundary 2-D holographic surface which contains all the information necessary to reconstruct the "bulk" 3-D universe (including its historical development) is apparently stored in the 2-D light waves which propagate forever throughout the "universal present moment" of the cosmos (see: ["A Spacetime Map of the Universe"](#)). Hence there is no need to "rescue" Quantum Mechanics from a crisis caused by the destruction of information in black holes - the information lives on anyway in causal history and in the propagating light waves of the "universal present moment" of spacetime.

Reconstituting the original information from such historical records or from propagating causal effects or light rays is certainly no less improbable or challenging than decoding the hidden messages in Hawking radiation, as Susskind suggests is possible. Furthermore, if the holographic principle is true to the model, then only a fragment of the original hologram is necessary to reconstitute an image of the whole, and such fragments should be abundantly present in the historical record. For example, we have been able to reconstruct the age of the dinosaurs from fossils, the evolutionary history of the cosmos from starlight, and the ontogeny of humanity from DNA.

### **3) Causality and the Conservation of Symmetry** (ordering information)

*Historic spacetime is the necessary conservation domain for information, charge, and matter's causal matrix.*

There is a metric component and a particle component to symmetry-breaking. The particle component produces charge and information, the metric component produces time and gravitation. The metric component of the symmetry pole (in the ["Tetrahedron Model"](#)) yields gravitation via the "location" charge, whose active principle is time. The particle component of the symmetry pole yields charge and fermions, or information, via the weak force IVBs.

Together, time, gravitation, and information create matter's causal matrix, the long-range aspect of historic spacetime, the repository of "karma" or consequences, the causal influence of actions. The trigger for gravitation is the conversion from implicit to explicit time, creating gravity and the asymmetric spacetime metric. This transformation can only occur if a massive, immobile particle (mass) is present to provide a center for the time or gravitational charge. Gravity, time, mass, charge, and information therefore always go together, and the causal relation applies to information as well as to action. (See: ["The Conversion of Space to Time."](#))

Charge conservation is the symmetry principle which allows weak force "symmetry-breaking" during the "Big Bang", because it guarantees the return of bound to free energy via charge annihilation in a future provided by the time dimension. *The charges of matter are the symmetry debts of light: "Noether's Theorem"*. Beyond the creation of the time dimension itself, the creation of information by charge conservation and the fermions of matter is the next most obvious connection between Causality (in the sense of "karmic information") and Symmetry Conservation. One must have information at some level to have an effect linked to a cause. Causality requires at a minimum time and gravitation, bound energy, and information.

History is the temporal analog of space, produced by the intrinsic motion of time, just as space is produced by the intrinsic motion of light. Gravitation and electromagnetism are the long-range forces

which bind together, order, and organize the cosmos at large, the orbits of the planets, the structure of the galaxies, the scale of the universe. But information itself also requires a causal or temporal ordering component, no less than raw energy, and for the same reason, energy conservation. In the case of information, the route is through the conservation of symmetry. The essential purpose of information is to provide a pathway back to symmetry and light for bound energy and matter in the absence of antimatter: *the charges of matter are the symmetry debts of light* and their purpose is to pay these debts by returning bound to free energy. Gravitation is one of these charges ("location") as we have seen, converting bound to free energy in stars, etc. Information must be time-ordered no less than energy if it is to fulfill its role of energy and symmetry conservation: causes must precede effects. The non-commutative rule of matrix multiplication in quantum mechanics is one basic example of the essential importance of order and sequence in both energy and information. The nucleosynthetic pathway in stars is another example. (See: "[The Information Pathway](#)".)

We have multiple obvious examples of the importance of the sequential ordering of information: the letters of a word, the words of a sentence, the grammar and syntax of a language. Language properly ordered produces poetry and literature; mathematics properly ordered produces equations and rational or at least quantitative understanding; notes properly ordered produce music; DNA properly ordered produces butterflies, birds, and humans; ideas properly ordered produces science and technology, etc. The sequential development of an individual human from fertilized egg through to adulthood is a prime example of why it is important to order information in time, no less than ordering simple energy or action. The evolutionary process itself is a further example of the sequential ordering of information through time. (See: "[The Fractal Organization of Nature](#)".)

Applying this example to the evolution of the universe, the problem posed by the creation of matter is this: can matter find its way back to its original symmetric energy state (light) in the absence of antimatter? The answer is yes, but it requires the extra dimension of

time to work the problem through with the information provided by the charges of matter - which is only half the information contained in the original particle-antiparticle pairs. The problem can be solved either gravitationally and "socially" by the conversion of mass to free energy in stars, quasars, and the quantum radiance of black holes, or "individually" by the nuclear forces through particle and proton decay.

"Karma" - the notion of causality extended to include a historic chain of events that returns to affect the initiator, is an ancient metaphysical recognition of cause and effect in human affairs. Its basis in fact is that the past remains as an active influence in the effects we experience in the present. There could be no present at all without the active support of the past - the "Universal Present Moment" depends for its reality upon the continuing reality of "Universal Historic Spacetime", the conservation domain of Information and matter's causal matrix.

From our material point of view, once matter enters the Cosmos, time and the causality relations time imposes become the dominating features of experience. This is why time, mass, and charge are the central organizing features of the Tetrahedron Model (in terms of bound energy) and comprise the three "internal" lines of the diagram. Time controls energy conservation through the ordering of cause and effect, the relative motion of massive objects and the invariant "Interval", including the extraordinary dimensional flexibility (covariance) of Special Relativity. The intrinsic and one-way motion of time produces the entropy drive of bound energy. Finally, time is the active principle of gravitation's "location" charge, leading on the one hand to the inertial and gravitational ordering of spacetime and the galaxies, and the conversion of mass to light in stars (restoring/conserving light's non-local distributional symmetry); and on the other hand ordering information in meaningful sequences that conserve and restore symmetry through nucleosynthesis and evolution, producing beauty in nature, and through humanity, science, art, and "enlightenment".

Although [elsewhere](#) we have noted (with [Chardin](#)) that information and consciousness are the significant evolutionary vectors of the Cosmos (life is how the Universe becomes self-aware and knows itself), from the narrow perspective of pure physics the evolution of information is seen as an auxiliary pathway, a sideshow, a tangent to the main work of the Universe, which is simply to return matter to its original symmetric state of light. Biology is an incredible elaboration of this neg-entropic information pathway. The principle drive is simply the abiotic and eternal search of matter for antimatter, realized through the long-range electrical and gravitational forces of matter. The evolution of information proceeds along the fractal pathway, and the production of beauty and enlightenment is the equivalent of symmetry conservation in this neg-entropic medium. Humanity has even learned to directly convert bound to free energy, reproducing the solar fusion process, a most curious evolutionary convergence between the abiotic and biotic neg-entropic information pathways leading toward symmetry restoration in the universe. Hence if we manage to destroy ourselves in a nuclear holocaust, we can always blame the immutable forces of symmetry conservation, rather than our own truculent stupidity.

In a less technically developed age, and on a more positive and humanistic note, Socrates had this to say concerning the ordering of information and its relationship to symmetry conservation and beauty (in Plato's [Symposium](#)):

"This is the life which man should lead above all others in the contemplation of beauty absolute ..... Dwelling in that realm alone, he will bring forth not images of beauty, but Beauty itself, and so would become immortal and be the friend of God."

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email:

jag8@cornell.edu  
johnagowan@earthlink.net

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## References

Books by Prof. J. C. Gowan, Sr. ["Trance, Art, Creativity" and "Operations of Increasing Order"](#)