Stellar Radiation Entropy as Evidence of Supernatural Order and Creation

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Abstract

The second law of thermodynamics, or increasing entropy, is one of the most fundamental and empirical laws of physics, and it holds great implications for understanding order and design in the universe and the origin of this order. Large increases in entropy from stellar radiation contribute to diffusion of energy and point to a high state of initial energy order that cannot be accounted for naturally or solely by the first law of thermodynamics. This is one of the greatest arguments for supernatural order that can only be the result of a Creator.

Introduction

The second law of thermodynamics is an immutable law of physics never violated by observation or experiment, and ever-increasing entropy in any closed or bounded system points directly to an earlier state of higher energy order. Sir Arthur Eddington was an English astrophysicist and contemporary of Einstein who theoretically investigated stellar interiors and temperature and first proposed that star radiation is a subatomic process, now known to be the nuclear fusion of hydrogen. Eddington (1929) wrote:

> The law that entropy always increases—the second law of thermodynamics—holds, I think, the supreme position among the laws of nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equations—then so much the worse for Maxwell's equations. If it is found to be contradicted by observation, well, these experimentalists do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation (p. 74).

More recently, Professor Thomas Banks of the Department of Physics, UC Santa Cruz, has stated, "The Second Law of Thermodynamics is one of the most robust and profound physical principles … Ever since the discovery of the Second Law, physicists have been faced with the question of why the universe began in a low entropy state" (Banks, 2007, p.1).

On the grandest cosmological scale, radiant energy from billions of stars illuminates the universe, producing a large and possibly the predominant entropy source along with quasi-stellar active galactic nuclei (AGN), gamma ray bursts (GRBs), and supernovae. For a numerical example, an estimate of stellar entropy demonstrates that a large source of energy and earlier state of order is required for this emission of radiant energy to even be possible. *Energy order* is a proposed conceptual term, which we will discuss in more detail later in this paper; it better quantifies energy as order as contrasted with the disorder of entropy.

Entropy is one of the greatest witnesses to God's sovereign power and control over the universe attested to by Scripture in Romans 8:20–21: "For the creation was subjected to futility, not of its own will, but because of Him who subjected it, in hope that the creation itself also will be set free from its slavery to corruption." †

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Stellar Radiant Energy Entropy

The most fundamental form of the second law of thermodynamics as established by Boltzmann, (Fermi, 1937) is:

$$S = k \ln w, \quad (1)$$

where S is the entropy in units of J/K, k is Boltzmann's constant, and *w* may be thought of as the thermodynamic probability of an isolated system being in a particular state, a dimensionless number that connects the microscopic, or statistical level, to the macroscopic, or classical measurements (Fermi, 1937, p. 57). This is true since *w* is the number of microstates corresponding to an observed macrostate as the measure or degree of disorder of a system. A change in entropy can be written by expanding equation (1) in differential form to compare microstates as

$$\Delta S = k \ln (w_f/w_i), \quad (2)$$

with *w* expanded into a ratio of microstates, the final microstate over the initial microstate. This equation follows from any ΔS as the macroscopic sum ($S = S_1 + S_2 + \ldots + S_n$) of a number of microscopic incremental dS changes (such as from radiant energy photons) equal to $S_f - S_i = (k \ln w_f) - (k \ln w_i) = k \ln (w_f/w_i)$. The initial or ground state of entropy, $w_i = 1$, corresponds to perfect order posited at creation (Van Ness, 1969, pp. 93–94). The differential increase in entropy also can be written as (Fermi, 1937, p. 52):

$$dS = dQ/T, \quad (3)$$

where dQ is the heat energy added to a closed system in thermodynamic equilibrium at temperature T and dS is the incremental transformation of energy into entropy. An estimate of the increase in the entropy of the universe due to stellar radiation as an entropy rate (from the appendix) is

$$dS/dt = dQ_T/(dtT_{cmb}) = n\sigma T_{avg}^{\ 4} A_s/T_{cmb}$$

$$= 1.16 \times 10^{49} \text{ [J/sK]}. \quad (4)$$

For an order-of-magnitude estimate of the stellar radiation contribution to the overall entropy change of the universe each second, we can equate the entropy change equation (2) per second and this expression for the rate of change of entropy from stellar radiation (4) to yield

$$k \ln (w_f/w_i) = n\sigma T_{avg}^{\ 4} A_s/T_{cmb}. \quad (5)$$

Therefore,

$$w_f/w_i = e\,\hat{}\,[(n\sigma T_{avg}^{\ 4} A_s)/kT_{cmb}], \quad (6)$$

where equation (6) is the ratio of microstates due to radiated energy from stars diffused each second into the quiescent radiation background or 'blackness' of space at $T_{cmb} = 2.725$ K. For the estimated number of stars at a median radiation temperature of 6000 K radiating from the total stellar surface area into the universe at T_{cmb}, equation (6) yields the ratio

$$w_f/w_i = e^{8.43 \times 10\hat{}71} \text{ or } \ln(w_f/w_i) = 8.43 \times 10^{71}. \quad (7)$$

This dimensionless number is the increase in microstates and disorder due to the energy radiated by all stars each second in the observable universe. The incremental entropy rate is the same numerical result as equation (4),

$$\Delta S = k[\ln(w_f/w_i)] = k(8.43 \times 10^{71}) = 1.16 \times 10^{49} \text{ [J/sK]}. \quad (8)$$

The total radiated energy each second from equations (3) and (4), dQ = (dS/dt)(T), or $(dS/dt)(T_{cmb}) = (1.16 \times 10^{49}$ J/sK)(2.725K) = 3.16×10^{49}J/s. This means that, for this example, the estimated entropy increase from stellar radiation across the universe during the 500 seconds it takes for sunlight to reach earth is 5.8×10^{51} J/K. From the first law of thermodynamics, dU/dt = dQ/dt – dW/dt, where dW/dt is the amount of work done per second, equal to zero in this case (Van Ness, 1969, p. 28). Given that dQ/dt = (dS/dt)(T), the rate of change of internal energy, dU/dt = (dS/dt)(T). Where did this large amount of energy radiated each second, dU/dt = 3.16×10^{49} J/s, originate? Could anything we know about in the natural universe be the source of this energy, or the high state of order transformed into entropy each second in equation (8)? Could this reasonably be accounted for as originating in another natural process, considering that all observed natural processes tend to increasing entropy and decreasing energy order? Or, if disorder results only from ordered energy, then what is the source of this order? Since energy cannot be created or destroyed naturally, and every natural or spontaneous process tends to disorder, then the origin of order cannot be natural but must be supernatural.

Discussion

The classical thermodynamics association of "disorder" with entropy is now being questioned because an increase in entropy, as an increase in disorder in any closed system as a completely natural process, is in direct conflict with evolution. Evolution is also defined as a natural or spontaneous process that supposedly "reverses" entropy with an unknown source of added energy. The escape from these philosophical entanglements is to require that entropy be restricted to

quantitative measurements in units of J/K. Equation (8) is a real entropy in J/K per second that requires initial energy order to enable the diffusion of energy. "Entropy is a measure of the unavailability of a system's energy to do work; *also a measure of disorder*; *the higher the entropy the greater the disorder*" (Daintith, 2005, emphasis added). In a recent paper, C. G. Chakrabarti and I. Chakrabarti state that *w* in equation (1) is "the degree of disorder or simply disorder of the system," and they rewrite equation (1) directly as "Entropy = k ln (Disorder)" (Chakrabarti and Chakrabarti, 2007, p. 560). Freeman Dyson, the Nobel laureate, has said, "The laws of thermodynamics decree that each quantity of energy has a characteristic quality called entropy associated with it. The entropy measures the degree of disorder associated with energy … The highest form (of energy) being the one with the least disorder or entropy." (Dyson, 1971, p. 52).

Therefore, as understood scientifically, entropy *is* disorder, or energy disorder. To quantify disorder with the necessary formalism, we can define "energy order" as the ratio of total energy to entropy, or the "orderliness" of energy in terms of the amount of disorder, fractionally. In the case of blackbody radiation, this radiant energy order as a ratio, $\mathcal{E}_0$, is

$$\mathcal{E}_0 = dU/dS = aT^4V/(4/3)aT^3V = \tfrac{3}{4}T \ \ [K] \qquad (9)$$

where the change in internal energy, $dU = aT^4V$ is the total radiant energy in a volume V, and $dS = (4/3)\,aT^3V$ is the magnitude of blackbody radiation entropy in the same volume, V (Planck, 1959). $\mathcal{E}_0$ is thus the energy order dependent solely on T, or temperature as the *quantification of thermal radiant energy order*. This logically follows from thermodynamics in general since thermal energy heat flow is always dependent on ΔT. The energy order of the CMB, for example, is $\tfrac{3}{4}(2.73K) = 2.05K$, or low energy order given the low usable energy-diffuse nature of the background radiation. The sun as a blackbody radiator at 5900 K has an energy order of 4425 K, much more usable energy, or much higher energy order than the CMB. $\mathcal{E}_0$ may thus be a useful metric and quantification of energy order over disorder, an indicator of available thermal radiant energy in terms of entropy. Eddington (1929, p. 71) states, "As regards heat-energy the temperature is the measure of its degree of organisation; the lower the temperature, the greater the disorganization." The quantification of energy order in terms of temperature is thus an inverse measure of entropy.

Entropy necessitates supernatural order and a Creator. Dr. Helge Kragh labels this the "entropic creation argument," highlighting a 1991 paper by Peter T. Landsberg, "From Entropy to God?" (Kragh, 2007, p. 369). Landsberg (1991) writes,

> The entropological 'proof' for the existence of God runs roughly as follows. The entropy law ensures that an isolated system reaches internal thermal equilibrium possibly after a finite time and certainly after an infinite time, after which only fluctuations about this equilibrium state can take place. As the universe is far from equilibrium it must have a finite age and hence a beginning. This beginning must be a state of minimum entropy at which the cosmos was born. This was brought about by God who also created values of parameters such as initial energy, matter, entropy and so on (p. 383).

Kragh (2008) adds that,

> Assuming that the law of entropy increase is valid for the universe as a whole, it is but a small step to conclude that the universe cannot have existed eternally. If so, it has presumably come into existence some finite time in the past, an event that many people would not hesitate to identify with a creative act. The claim that thermodynamics leads to a finite-aged, created universe has been called the entropological or *entropic argument* for creation (p. 47).

Similarly, Bishop E. W. Barnes (1933) has written,

> It is a singular fact that … speculations based on the second law of thermodynamics seem to re-establish the cosmological argument (for the existence of God) with the utmost directness and simplicity. The organisation of the energy of the cosmos is always diminishing…as a result of it there will finally be in the cosmos no organised energy capable of doing work. In the beginning there must have been a maximum organisation of energy … Against this thermodynamical argument we can bring no valid objection (pp. 595–596).

This was summarized best, however, by Dr. Henry Morris Jr., founder and past president of the Institute for Creation Research, in his paper, "Entropy and Open Systems":

> The entropy principle points directly to creation. That is, if all things are now running down to disorder, they must originally have been in a state of high order. Since there is no naturalistic process which could produce such an initial condition, its cause must have been supernatural (Morris, 1976, p. 6).

Dr. Gordon Van Wylen, former chairman of the Department of Mechanical Engineering at the University of Michigan, has commented that the question that arises is how the universe got into the state of reduced entropy in the first place, since all natural processes known to us tend to increase entropy. Van Wylen and Sonntag conclude this subject by stating, "How did [the universe] get in the low state of entropy? … the authors see the second law of thermodynamics as man's description of the prior and continuing work of a creator" (Van Wylen and Sonntag, 1973, p. 248). It is fitting to conclude this section with a comment by Eddington (1933):

> It is the opposite extrapolation towards the past which gives real cause to suspect a weakness in the present conception of science. The beginning seems to present insuperable difficulties unless we agree to look on it as frankly supernatural. We may have to let it go at that (pp. 124–125).

Conclusion

Entropy increase ranks among the most absolute and observable physical principles in the universe. Everything is becoming increasingly disordered in terms of available energy because entropy, the disordering of energy, is irreversibly increasing as demonstrated by the large entropy change from star radiation. If this diffusion of energy is quantifiable and real, then it must result from preextant energy order that is just as quantifiable and real, and this ordered state also cannot be accounted for as originating from another natural, entropy-increasing process. This quantification of order implies design as believed by Eddington (1929):

> "We admit that the world contains both chance and design, or at any rate chance and the antithesis of chance. This antithesis is emphasized by our method of the measurement of entropy" (p. 77).

The initial or originating order must be the result of a supernatural process, from the Creator Himself. Again, from Eddington (1929):

> Travelling backwards into the past we find a world with more and more organisation. If there is no barrier to stop us earlier we must reach a moment when the energy of the world was wholly organized with none of the random element in it. It is impossible to go back any further under the present system of natural law (p. 84).

In the apostle Paul's letter to the Romans, he writes, "For since the creation of the world His [God's] invisible attributes, His eternal power and divine nature, have been clearly seen, being understood through what has been made" (1:20). The word for "world" used here is the Greek word *kosmos*, which means "order," the subject of this paper. Looking at "His eternal power" in this verse in more detail, the Greek word for power is *dynamis*, which means "[miraculous] power, might, or strength, or the ability to accomplish a task or do work (Thomas, 1981, p. 1644). This could be interpreted identically with the scientific definition of power, the capacity to exert energy or do work per unit time in units of watts or Joules/second. The applied energy, then, in Romans 1:20 would be power (in watts, or J/s) x time (s) with $t \rightarrow \infty$, *which means infinite energy*. This source of infinite energy can only be the infinite God who created the universe with the high state of initial order attested to by the increasing entropy we observe. One of the greatest evidences of the supernatural God of the universe is the increase in entropy and disordering of energy in all natural processes, which can only be the result of the initial order established by God Himself and understood through what has been made. The logical conclusion of Dr. Emmett Williams is:

> It seems more reasonable to believe that the existing order and complexity in the physical universe was created into it by God … Scientific laws overrule the process of evolution … Evolution is neither a conservative nor a degenerative process. Therefore it is concluded that evolution could not have occurred, since the first and second laws of thermodynamics would prevent any process that consistently produces greater order and complexity in the physical universe (Williams, 1981, pp. 21–22).

Again, from Eddington (1929),

> As a scientist I simply do not believe that the present order of things started off with a bang; unscientifically I feel equally unwilling to accept the implied discontinuity in the divine nature [that God wound up the material universe and left it to chance ever since]. But I can make no suggestion to evade the deadlock (Eddington, 1929, pp. 84–85, brackets added).

We cannot see the infinite, eternal God directly, but we can understand more about Him through what has been made and how the creation is increasingly disordered in terms of available energy according to His Word. In Romans 8:20–22, we read:

> For the creation was *subjected to futility*, not of its own will, but because of Him who subjected it, in hope that the creation itself also will be set free from its *slavery to corruption* into the freedom of the glory of the children of God. For we know that the whole creation groans and suffers the pains of childbirth together until now (emphases added).

This observed trend to disorder necessarily leads us to order, and the order of the universe is the most overwhelming proof of the existence of the God of the Bible. German Nobel laureate, physicist Max Planck, explains this order in a May 1937 address.

> At all events we should say in summing up that, according to everything taught by the exact sciences about the immense realm of nature … a certain order prevails—one independent of the human mind. Yet, in so far as we are able to ascertain through our senses this order can be formulated in terms of purposeful activity. There is evidence of an intelligent order of the universe (Planck, 1968, p. 144).

Entropy is the observable transformation of ordered energy into a less ordered state. This posits a supernatural source of order that was understood by Einstein. In his biography of Einstein, Isaacson (2007) writes:

> But mainly, his beliefs seemed to arise from the sense of awe and transcendent *order* that he discovered through his scientific work. Whether embracing the beauty of his gravitational field equations or rejecting the uncertainty in quantum mechanics, he displayed a profound faith in the *orderliness* of the universe" (p. 385, emphases added).

References

Banks, T. 2007. Entropy and initial conditions in cosmology. *Journal of High Energy Physics*, eprint: arXiv:hep-th/0701146V1

Barnes, E. 1933. *Scientific Theory and Religion*. Cambridge University Press, Cambridge, and Bentley House, London, UK.

Britt, R. 2003. Imperfect estimate claims universe has 70 sextillion stars. Science News at Space.com.

Chakrabarti, C., and I. Chakrabarti. 2007. Boltzmann entropy: probability and information. *Romanian Journal of Physics* 52:5–7; 559–564.

Daintith, J. 2005. *Oxford Dictionary of Science*. Oxford University Press, Oxford, UK.

Dyson, F. 1971. Energy in the universe. *Scientific American* 225(3):51–59.

Eddington, A. 1929. *The Nature of the Physical World*. Macmillan, New York, NY.

Eddington, A. 1933. *The Expanding Universe*. Cambridge University Press, Cambridge and Bentley House, London, UK.

Fermi, E. 1937. *Thermodynamics*. Dover Publications, Inc., New York, NY.

Gitt, W. 1996. *Stars and Their Purpose, Signposts in Space*. Christliche Literatur-Verbreitung e.V., Bielefeld, Germany.

Goddard Space Flight Center. 2008a. Hertzsprung-Russell diagram, http://imagine.gsfc.nasa.gov/docs/teachers/lifecycles/Image31.gif. (Accessed, May, 2008)

Goddard Space Flight Center. 2008b. Wilkinson Microwave Anisotropy Probe (WMAP) five year results on the oldest light in the universe, http://map.gsfc.nasa.gov/news/index.htm. (Accessed, June, 2008)

Isaacson, W. 2007. *Einstein, His Life and Universe*. Simon & Shuster, New York, NY.

Kragh, H. 2007. Cosmology and the entropic creation argument. *Caliber Historical Studies in the Physical and Biological Sciences* 37(2):369–382.

Kragh, H. 2008. *Entropic Creation, Religious Contexts of Thermodynamics and Cosmology*. Ashgate Publishing Company, Burlington, VT.

Landsberg, P. 1991. From entropy to God? In Martinas, K., L. Ropolyi, and P. Szegedi (editors), *Thermodynamics: History and Philosophy*, pp. 379–403. World Scientific Publishing Co., Singapore, Malaysia.

Morris, H., Jr. 1976. Entropy and open systems. Acts and Facts, http://www.icr.org/article/entropy-open-systems. (Accessed, March, 2009)

Planck, M. 1959. *The Theory of Heat Radiation*. Dover Publications, Inc., Mineola, NY.

Planck, M. 1968. May 1937 address. In Barth, A. (editor), *The Creation in the Light of Modern Science*, pp. 135–149. Jerusalem Post Press, Jerusalem.

Simon, R. 1974. *Electro-Optics Handbook*. RCA Corporation Technical Series EOH-11, Burlington, MA.

Thomas, R. 1981. *Exhaustive Concordance of the Bible*. Holman Bible Publishers, Nashville, TN.

Van Ness, H. 1969. *Understanding Thermodynamics*. McGraw-Hill Book Company, New York, NY.

Van Wylen, G., and R. Sonntag. 1973. *Fundamentals of Classical Thermodynamics (Thermal and Transport Science) 2nd Edition*. John Wiley & Sons, Inc., New York, NY.

Weisstein, E.. 2007. Radiation constant (definition). Wolfram Research, Scienceworld.wolfram.com

Williams, E. (editor). 1981. *Thermodynamics and the Development of Order*. Creation Research Society Books, St. Joseph, MO.

Appendix: An Estimate of Stellar Radiation Entropy

For ideal blackbody radiant energy-heat transfer into free space at a low T(K) with transmissivity e ≈ 1,

$$Q = U = aT^4V \ [J] \qquad \text{(i)}$$

(Planck, 1959, p. 63). This is the energy of blackbody radiation at T(K) in a volume V which is the total radiant energy in Joules with the radiation density constant $a = 8\pi^5k^4/15c^3h^3 = 7.57 \times 10^{-16}$ J/m^{3}K^4, and Boltzmann's constant $k = 1.38 \times 10^{-23}$ J/K (Weisstein, 2007); and T is the radiation temperature of the blackbody source.

We can better quantify radiant energy transfer in terms of radiant exitance or radiant emittance from an emitting surface, M, in $Js^{-1}m^{-2}$ or wm^{-2}, as from the surface of an emitting star. Energy dQ/dt radiated each second would then be,

$$dQ/dt = \Phi = MA_s = \sigma T^4A_s \ [Js^{-1}] \qquad \text{(ii)}$$

(Simon, 1974, p. 36), where σ is the Stefan-Boltzmann constant = 5.67×10^{-8} $wm^{-2}K^{-4}$; M is the radiant exitance, from the Stefan-Boltzmann equation; A_s is the spherical surface area of the emitting star, and using our sun as the median main sequence star, $A_s = 4\pi R_s^2$ and radius of the sun ~ 7×10^8 m; T is the radiant energy temperature; and Φ is the radiant flux in Js^{-1} or watts.

For an order-of-magnitude calculation, we can estimate dQ/dt for the number, n, of stars in the observable universe or "Hubble volume" using (1) A median radiation temperature, T_{avg} of 6000K for stars derived from the Hertsprung-Russell (H-R) diagram line of main sequence stars (90% of all stars) with similar radiation temperature to our sun's photosphere at 5900K (Simon, 1974), a typical main sequence star (Goddard Space Flight Center, 2008a); and knowing that (2) star radiant energy closely conforms to the ideal blackbody radiation spectrum (Simon, 1974). A_s is the spherical surface area of the average main sequence star like our sun = 4π $(7 \times 10^8 m)^2$ =

6.16×10^{18} m^2. Equation (ii) now becomes a total star radiant energy rate,

$$dQ_T/dt = M_T A_s = \Phi_T = n\sigma T_{avg}{}^4 A_s \ [J/s], \qquad (iii)$$

where n is approximately 7×10^{22} stars (Britt, 2003). This is a conservative number since some scientists think it may be higher. "Today the total number of stars in the observable universe is estimated to be 10^{25} … Nobody knows the actual number" (Gitt, 1996, p.19). Combining equations (3) and (iii) we can estimate the entropy change dS due to stellar radiation each second as

$$dS/dt = dQ_T/(dt\ T_{cmb}) = n\sigma T_{avg}{}^4 A_s/T_{cmb}$$

$$= 1.16 \times 10^{49} \ [J/sK], \qquad (iv)$$

where T_{cmb} is the equilibrium temperature of the cosmic microwave background radiation (CMB), also a blackbody spectrum at 2.725K (Goddard Space Flight Center, 2008b). Entropy rate, dS/dt, here, is an estimate of total stellar radiant energy diffusion into the universe each second.

Book Review

God of Wonders

DVD
produced by Jim Tetlow

Eternal Productions, 2008,
85 minutes, $20.00.

This DVD is hosted by Dr. John Whitcomb and features stunning photography and computer animation. It highlights the glories of nature including deep space, hummingbirds, and atomic details. The program demonstrates that the glory of God is evident throughout the created world. There are four subsections to the film featuring God's power, wisdom, justice, and love. The producers show how these attributes of God can be clearly seen in nature and the human conscience. The last part of the production deals with the sinful state of man and the remedy for that state, Jesus Christ.

The substance of the video includes interviews with several creation scientists including Don DeYoung, Jason Lisle, and Larry Vardiman. Each interview focuses on some aspect of creation or life forms which highlights attributes of the Creator. There is special coverage of thunderstorms, the energy within the atom, and the design of the butterfly and hummingbird. The quality of the nature footage is spectacular, although some of the interviews are less professional.

The last two sections of the DVD include confrontational interviews with people about their conscience and what this tells us about God. The gospel message is clearly presented in the last section of the video entitled "God of Love." This video is a valuable asset to the creationist library, and promises to appeal to young and older audiences alike.

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