The Planetary-Stellar Mass-Luminosity Relation: Possible Evidence of Energy Nonconservation?

Paul A. LaViolette

Abstract

The mass-luminosity coordinates for the Jovian planets are found to lie along the lower main sequence stellar mass-luminosity relation, suggesting that both planets and red dwarf stars are powered by a similar non-nuclear source of energy. These findings support a prediction of subquantum kinetics that celestial bodies produce "genic" energy due to non-Doppler blueshifting of their photons at a rate that depends on the value of their ambient gravity potential. Genic energy also accounts for 40% of the Moon's thermal flux, all the Earth's core heat flux, and over half of the Sun's luminosity, thereby resolving the mystery of the Sun's low neutrino flux. The upward bend in the mass-luminosity relation and inflection in the luminosity function at 0.45 $M_\odot$ are attributed to the onset of nuclear burning, fusion reactions igniting at a greater stellar mass than had been previously supposed.

Key words: energy conservation violations, planets, stars, white dwarfs, mass-luminosity relation, luminosity function, genic energy, fusion energy, solar neutrino problem, supernovas, galactic core explosions, cosmological redshift, subquantum kinetics

1. INTRODUCTION

The notion that energy is strictly conserved is a universally accepted hypothesis, but nevertheless, only a hypothesis. From an observational point of view, one can reasonably claim only that a photon's energy is conserved *to within experimentally verifiable limits*. Laser interferometery provides one of the best ways of determining the energy constancy of a photon beam in the laboratory. The frequency of the iodine-stabilized He–Ne laser can be shown to be stable to about one part in 3×10^{13} over a 10^5-s sample integration time. A null result from interferometric measurements made on a 100-m beam from such a laser would establish only that the rate of energy change in the beam's photons was less than 10^{-7} s^{-1}.

Such an assurance level, while sufficient for adhering to the energy conservation assumption when considering physical phenomena observed in a laboratory, is insufficient where astronomical phenomena are concerned. Nonconservative energy change rates far smaller than this can be tremendously important in the astrophysical arena, particularly in considering the rate of energy generation in stars. Consider the Sun, for example. The Sun's total thermal energy content may be roughly estimated as $H_\odot = \bar{C}M\bar{T} = 4.5 \times 10^{48}$ erg, where $\bar{C}$, M, and $\bar{T}$ are the Sun's average specific heat, mass, and average internal temperature. Consequently, the Sun's luminosity of 3.9×10^{33} erg $\cdot$ s^{-1} could be entirely explained if its energy quanta were to increase their energies at a rate of just 10^{-15} s^{-1}. This photon blueshifting rate is eight orders of magnitude smaller than the smallest energy change detectable with laboratory instrumentation. Therefore, we may be justified in attributing a substantial portion of the Sun's luminosity to such a non-nuclear mechanism. This may not be totally unreasonable, since fusion models are unable to adequately account for the low solar neutrino flux, which averages about 25% ± 12% of the expected amount in ^{37}Cl detectors and 46% ± 13% in the Kamiokande-II neutrino detector.(1) This discrepancy could be resolved if fusion supplied about one-third of the Sun's energy, with the remaining two-thirds coming from photon energy amplification (non-Doppler blueshifting).

Conservation law violations of comparable magnitude would also have important consequences for cosmological theory. For example, a photon energy loss rate of only $d/dt(dE/E) = -H_0 = -3.1 \times 10^{-18}$ s^{-1} (or a 9.7% change for every billion light-years traveled) is able to entirely account for the cosmological redshift effect.(2) This energy loss rate is about ten orders of magnitude smaller than the laboratory observation limit. The existence of such a "tired-light" redshifting phenomenon would obviate the need for an expanding universe and weigh against a big bang origin. In fact, several studies demonstrate that cosmological test data as well as simple logic favor a stationary universe tired-light cosmology over an expanding-universe cosmology.[3] Although several have suggested energy-conserving tired-light mechanisms in which the "lost" energy remains in the physical universe in degraded form, nonconservative mechanisms also predicting a permanent loss of energy from the objective physical universe also offer a plausible alternative.[4,5] Even Maxwell considered the possibility of nonconservative photon behavior. His original electromagnetic wave equation contained the energy-damping term $\sigma_0 \mu_0 \; \partial\phi/\partial t$, where σ_0 represented the electrical conductivity of background space.[6] The next section summarizes an approach that predicts nonconservative photon energy behavior, even though the *subquantum* reactions it hypothesizes as the basis of objective physical phenomena are themselves conservative.

2. A NONCONSERVATIVE FIELD THEORY

Subquantum kinetics, a nonlinear unified field theory, predicts that photons should behave in a nonconservative manner in most regions of space, redshifting in intergalactic space and blueshifting in the vicinity of galaxies, the sign and magnitude of a photon's rate of energy change depending on the magnitude of the ambient gravitational potential, ϕ_g, relative to a particular critical value ϕ_{gc}.[5,7] This is the first theory of its kind to apply an open system reaction-kinetics methodology to microphysics. It allows us to describe microphysical phenomena with conceptual and mathematical tools similar to those used in chemistry and the life sciences (e.g., biology, sociology, ecology, and economics), thus making possible a unified approach to systems phenomena. The basic subquantum kinetics equations spawn subatomic particlelike structures that surround themselves with fields (concentration gradients) that accurately portray electrostatic and gravitational energy potential fields. A few advantages of this physics are: it resolves the wave-particle dualism, field-particle dualism, the particle dispersion conundrum, and infinite energy absurdity. In oscillatory motion their fields produce radiant energy waves.

The nonconservative wave equation for radiant energy in subquantum kinetics is derived below. Those who are not familiar with the reaction kinetics methodology, more commonly utilized in chemistry and nuclear engineering, may wish to consult the main papers on subquantum kinetics, which more fully explain the approach.[5] The five kinetic equations given below together specify one possible subquantum kinetics reaction-diffusion system model. This Brusselator-like system is called Model G:

$$\begin{gathered} A \xrightarrow{k_1} G, \quad G \xrightarrow{k_2} X, \\ 2X + Y \xrightarrow{k_3} 3X, \quad B + X \xrightarrow{k_4} Y + Z, \quad X \xrightarrow{k_5} \Omega. \end{gathered} \tag{1}$$

These represent a set of inherently unobservable nonequilibrium reaction processes hypothesized to take place throughout all of space among various types of subquantum units – "etherons." The letters denote spatial concentration magnitudes of these ether media: A and B are the initial reactants; G, X, and Y are the reaction intermediates; and Z and Ω are the final products. Parameters k_1 through k_5 specify the reaction rate constants for these reactions. Model G (1) is expressed in time-dependent form by the following set of nonlinear partial differential equations:

$$\begin{aligned} \partial G/\partial t &= k_1 A - k_2 G + D_g \; \partial^2 G/\partial r^2, \\ \partial X/\partial t &= k_2 G + k_3 X^2 Y - k_4 BX - k_5 X + D_x \; \partial^2 X/\partial r^2 \\ \partial Y/\partial t &= k_4 BX - k_3 X^2 Y + D_y \; \partial^2 Y/\partial r^2 . \end{aligned} \tag{2}$$

where D_i are the diffusion coefficients for each variable specie.

Energy potential is identified with the deviation of a specie concentration above or below its *steady-state* concentration value. Thus if G_0, X_0, and Y_0 are the steady-state values for variables $G(r)$, $X(r)$, and $Y(r)$, then gravity potential is measured as $\phi_g(r) = G(r) - G_0$, and electrostatic potential is measured by $\phi_x(r) = X(r) - X_0$ and $\phi_y(r) = Y(r) - Y_0$, X and Y being complementary reactants that exhibit an interdependent reciprocal relationship.

The reaction system is *subcritical* when $G > G_c$ and *supercritical* when $G < G_c$, where G_c the critical value that brings the system to its threshold of marginal stability. Specifying the critical gravitational potential value as $\phi_{gc} = G_c - G_0$ (where $G_c < G_0$), the system is subcritical when $\phi_g > \phi_{gc}$ and supercritical when $\phi_g < \phi_{gc}$. Under supercritical conditions the reaction processes amplify energy fluctuations (concentration fluctuations) that arise spontaneously in the subquantum medium, and these eventually give rise to localized energy densities, subatomic particles that possess both "charge" and "mass" characteristics, and that generate radially disposed $\phi_g(r)$, $\phi_x(r)$, and $\phi_y(r)$ potential fields consistent with the laws of classical electrostatics and gravitation. Motion of a ϕ_x and ϕ_y electrostatic potential field can induce forces equivalent to the magnetic forces of Ampère.

An oscillating ϕ_x and ϕ_y field produces propagating reaction-diffusion waves, representing waves of radiant energy. A general expression for the propagation of a reaction-diffusion wave in a single r dimension is given as[8]

$$\phi_x(r, t) = \exp[i(\mathcal{k}_R r - \omega t)] \exp(-\mathcal{k}_i r), \tag{3}$$

or

$$\mathcal{A}(r) = \mathcal{A}_0 \exp(-\mathcal{k}_i r), \tag{4}$$

where $\mathcal{A}_0$ is the wave's initial amplitude, $\mathcal{A}(r)$ is its amplitude at distance r, and $\mathcal{k}_R$ and $\mathcal{k}_i$ are the real and imaginary parts of the wave number $\mathcal{k} = 2\pi/\lambda$. For $\mathcal{k}_i = 0$, the wave amplitude stays constant; for $\mathcal{k}_i < 0$, supercritical conditions prevail and wave amplitude gradually increases; and for $\mathcal{k}_i > 0$, subcritical conditions prevail and wave amplitude gradually decreases.

In a similar fashion, for Model G wave energy may be written as

$$E(t) = E_0 \exp[\alpha(\phi_{gc} - \phi_g)t], \tag{5}$$

where $E(t)$ is the energy of the wave at time t, and α is a constant of proportionality. The reaction system generates energy-conserving time-invariant waves only for regions of space where the subquantum reaction system is operating at the critical threshold; that is, where $\phi_g = \phi_{gc}$. In all other regions of space the wave's energy would be nonconservative. In the vicinity of galaxies, where gravitational potential is particularly negative, supercritical conditions would prevail ($\phi_g < \phi_{gc}$), causing wave energy to progressively increase with time and photons to blueshift; see Fig. 1. In intergalactic regions of space, where gravitational potential is much less negative, subcritical conditions would prevail ($\phi_g > \phi_{gc}$) causing wave energy to progressively decrease with time and photons to redshift. Again, it should be emphasized that the nonconservative wave behavior portrayed by this equation emerges as a *prediction* of subquantum kinetics.

Care should be taken not to confuse this photon redshifting and blueshifting effect with the gravitational redshift, which is another effect derivable from subquantum kinetics. The gravitational redshift (or blueshift) only occurs in response to a change in the ambient gravitational potential,

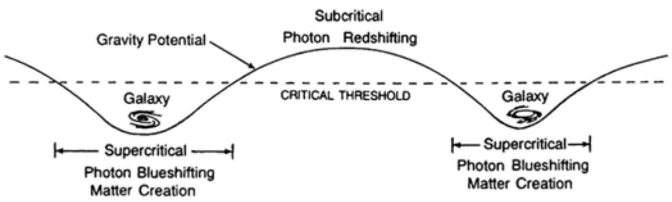

Figure 1. Subquantum kinetics predicts that photons progressively blueshift in the vicinity of galaxies and progressively redshift in intergalactic space.

as when a photon leaves (or approaches) the surface of a star. The nonconservative effect described here occurs even when there is no change in gravitational potential.

3. GENIC ENERGY

The present paper evaluates the subquantum kinetics photon blueshifting prediction, namely, the energy relation

$$dE/dt = \mu E, \tag{6}$$

where $\mu = \alpha(\phi_{gc} - \phi_g)$, and ϕ_g is the ambient gravitational potential. The value suggested for α is sufficiently small that photons traveling through the galaxy accrue blueshifts of less than three parts per million over a distance of 30 kpc, equivalent to a 1 km/s Doppler shift. Hence the effect would be undetectable in the spectra of stars within our galaxy. However, it would make quite a substantial contribution to the internal energetics of planets and stars. The heat stored in a celestial body would spontaneously evolve blueshifted "genic" energy at the rate

$$L_g = dE/dt = \mu H = \alpha(\phi_{gc} - \phi_g)\bar{C}M\bar{T}. \tag{7}$$

This created genic energy comes from the underlying subquantum reactions. Whereas the nineteenth-century mechanical ether was an inert and inactive substance, the subquantum kinetics ether reactions operate in a continuous nonequilibrium state continuously building up the G, X, and Y concentrations that compose the physical universe. While the unobservable subquantum reactions may be assumed to behave in a conservative manner, the observable field amplitudes they produce can behave nonconservatively, allowing entropy to stay constant or even decrease over time. Such are the characteristics of an open system. Clearly, a physics that allows the continuous creation of negative entropy is advantageous from a cosmological standpoint, since it can explain the origin of the universe.[5]

The genic energy production rate of a celestial body of radius R and mass M may be more precisely expressed as

$$L_g(M) = \int_0^R dLdr$$
$$= 4\pi\alpha \int_0^R \phi_g(r, M)C(r, M)T(r, M)\rho(r, M)r^2 dr, \tag{8}$$

where r is the radius of a shell of thickness dr, and $\rho(r, M)$ is the mass density within the shell. The $T(r, M)$ and $\rho(r, M)$ values found in the conventional equation-of-state models formulated for brown dwarfs and hydrogen-burning stars are inappropriate for the case where genic energy makes a substantial contribution. For example, compared with a conventional brown dwarf (that is adiabatically cooling and devoid of a supplemental internal heat source), a genic-energy-producing dwarf would present a lower core density and higher core temperature. This is because a disproportionately greater amount of heat energy would be produced at the star's center due to the temperature and density dependencies of the genic energy production process. The opposite situation prevails when comparing a star powered entirely by thermal fusion to a star powered by a combination of genic and fusion energy. Hence a genic energy-producing star would have a higher central density and lower central temperature. Unlike fusion, which is restricted to a star's core, genic energy would arise in substantial amounts throughout the star's volume.

Using currently available model parameters for the temperatures and densities in the cores of brown dwarfs and main sequence stars, it should be possible to place rough bounds on the size of the exponent x for the genic energy mass-luminosity relation $L_g \propto M^x$. At the one extreme we take the brown dwarf evolutionary track model of Nelson, Rapparport, and Joss,[9] which models electron degenerate stars that follow cooling tracks. These stars are assumed to have convective cores, an $n = 3/2$ polytrope, and no energy source other than the heat stored from gravitational collapse. There model indicates that for dwarfs of the age 10 billion years and masses ranging from 0.01 $M_\odot$ to 0.08 $M_\odot$, central temperature and density vary with stellar mass as $T_c \propto M^{1.38}$ and $\rho_c \propto M^{1.74}$. Given these T_c and ρ_c dependencies and knowing that $\phi_g \propto M/R \propto M^{2/3}\rho^{1/3}$, relation (7) yields a mass-luminosity relation mass dependency of $L \propto M^{3.6}$.

At the other extreme, we may consider and density variations for hydrogen-burning main sequence stars in the mass range $0.08\, M_\odot < M < 0.35\, M_\odot$. In the model of Dorman, Nelson, and Chau,[10] which uses the equation of state formulated by Fontaine-Graboske and Van Horn[11] and assumes an $n = 3/2$ polystrope, central temperature and density vary with stellar mass as $T_c \propto M^{0.65}$ and $\rho_c \propto M^{-1.41}$. Substituting these dependencies into (7) gives a mass dependency of $L \propto M^{1.8}$. Consequently, the genic energy mass-luminosity relation would be expected to have a mass exponent that lies somewhere between these two extremes; hence $1.8 < x < 3.6$, or in other words $x \sim 2.7 \pm 0.9$. By constructing an equation of state stellar model that includes genic energy as a principle energy source, the value of this exponent may be more precisely estimated.

4. THE PLANETARY-STELLAR MASS-LUMINOSITY RELATION

Harris *et al.*[12] performed a least squares fit to the log L–log M data for two dozen lower main sequence stars having bolometric magnitudes fainter than +7.5 ($L < 0.07\, L_\odot$) and obtained a regression line of log $L = 2.76$ log $M - 58.55$, where M is given in grams and L in erg s^{-1}. Their data points and regression line are plotted in Fig. 2. Interestingly, the mass exponent of this mass-luminosity relation, 2.76 ± 0.15, falls close to the above theoretical median value of $x = 2.7 \pm 0.9$.

Veeder[13] has reported a substantially lower log L–log M slope of 2.2 ± 0.2 for a sample of lower main sequence stars. However, he minimized the y-axis (luminosity) residuals in performing his least squares fit. Since the log L–log M data slopes rather steeply and spans a relatively restricted mass range, minimizing the y-axis residuals tends to underestimate the actual slope and yield a skewed fit to the data. It is instead preferable to minimize the x-axis (mass) residuals. When this is done, the slope becomes 2.6 ± 0.2, a value that lies within 1σ of the Harris *et al.* value.

To check the positions of the heavy planets relative to the downward extension of the lower main sequence mass-luminosity relation, the intrinsic

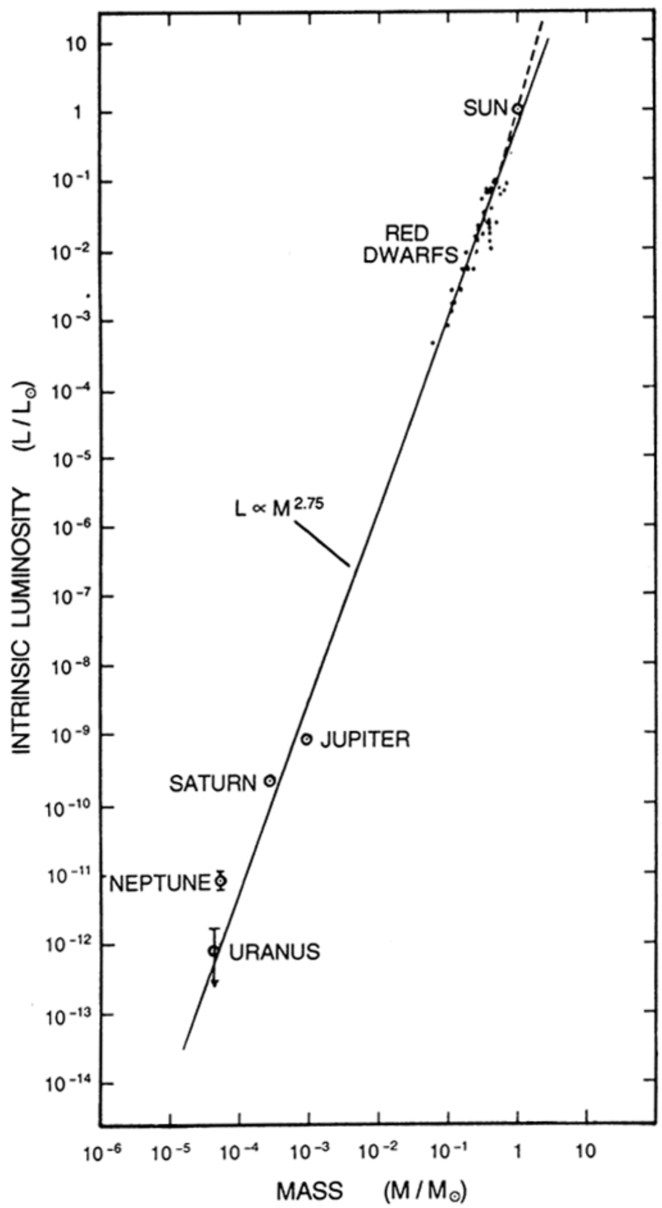

Figure 2. The position of the planets shown in relation to an extension of the lower main sequence stellar mass-luminosity relation.

luminosity values for several planets have been plotted in Fig. 2. As is seen, these planetary mass-luminosity points fall quite close to the stellar relation. This correspondence was first discovered in 1978 in checking out this genic energy prediction. Brown dwarfs and planets having masses less than $0.08\ M_\odot (L < 5 \times 10^{-4}\ L_\odot)$ are conventionally assumed to derive their radiated energy from a store of primordial heat acquired as a result of gravitational collapse and accretion. Accordingly, the luminosity of such a body would be expected to constantly decrease in the course of its approach to thermodynamic equilibrium, the main factor governing its luminosity being the amount of time elapsed since its initial formation. Hence the mass-luminosity coordinates for such objects would not necessarily be expected to coincide with the main sequence mass-luminosity relation. On the basis of conventional theory, it is quite unexpected to find the mass-luminosity coordinates of the Jovian planets falling so close to the stellar relation. Ascribing their luminosities solely to primordial heat would suggest that we are observing them at a time in their cooling histories when they all fortuitously coincide with the stellar mass-luminosity relation.

Table I: Intrinsic Luminosities for the Jovian Planets, Earth, and Moon.

Planet	*Wavelength* (μm)	*Bond Albedo*	L_{int}/L_{sun}	*log* L_{int} (erg/s)
Jupiter	$2-50$	0.34 ± 0.03	0.67 ± 0.09	24.53 ± 0.03
Saturn	$2-50$	0.34 ± 0.03	0.78 ± 0.09	23.94 ± 0.03
Uranus	$2-50$	0.39 ± 0.05	0.06 ± 0.08	21.53 ± 0.33
Neptune	$2-50$	0.31 ± 0.04	1.6 ± 0.3	22.52 ± 0.04
Earth	...	...	...	20.60
Moon	...	...	...	18.84

The luminosities for Jupiter, Saturn, Uranus, and Neptune are from the *Voyager* infrared data.[14] Table I lists the infrared spectral range observed, the value adopted for the planet's surface albedo, the ratio of the planet's intrinsic luminosity to energy flux received from the Sun, and the log of the planet's intrinsic luminosity. Intrinsic heat measurements for the smaller planets have been made only for the Earth and Moon, in this case by directly measuring their subsurface thermal gradients with implanted probes. *Voyager 2* has found indirect evidence of an internal heat source on the surface of Neptune's moon Triton, in the form of a liquid nitrogen geyser spouting from Triton's frozen nitrogen surface. According to subquantum kinetics, this geothermal geyser would be powered by the same type of energy that powers Jupiter's red spot and Neptune's brown spot – genic energy.

Adiabatic cooling models predict a temperature and luminosity close to Jupiter's observed value for a cooling time comparable to the age of the solar system ($t \sim 4.5$ billion years).[15–18] However, adiabatic cooling has greater difficulty explaining Saturn's thermal output. A cooling model similar to Jupiter's accounts for only about half of Saturn's observed luminosity. For cooling to account for all of its output, Saturn would have to be unusually young, about 2.8 ± 1.2 billion years old.[19,20] To resolve this problem, alternate energy generation mechanisms have been proposed. One suggests that Saturn is releasing heat as a result of a gradual contraction process.[21] Another suggests that it is releasing heat as a result of the phase separation and gravitational settling of He from an initially uniform H–He mixture.[21–23]

Uranus and Neptune also present problems for the standard adiabatic cooling model. In this case the observed intrinsic luminosities are low compared with expected cooling model values. As a possible explanation Hubbard and MacFarlane[24] have suggested that these planets had low luminosities at the time of their formation, only a few times higher than their present luminosities. However, such a scenario requires that the circumstances surrounding the formation of these two planets were substantially different from those involved in the formation of Jupiter and Saturn, for which initial luminosities on the order of 10^6-fold higher are usually proposed.[16] Alternatively, Stevenson[20] has suggested that a cooling mechanism may be in operation in these planets, whereby an initially density-stratified planetary interior becomes homogenized, and hence cooled, as a result of convection.

Jones *et al.*[25] have proposed that cold nuclear fusion might be the source of the intrinsic energy fluxes observed to emanate from the Earth and Jovian planets. However, while this might be feasible for planet-sized bodies, stars would exhaust their deuterium supply within a few million years due to their much higher luminosities. Consequently unlike genic energy, cold fusion does not explain why the planets share a common mass-luminosity relation with lower main sequence stars.

5. UPPER MAIN SEQUENCE STARS

If the planets and lower main sequence stars are powered by genic energy, then by projecting their mass-luminosity relation up to 1 $M_\odot$ we may determine the genic energy contribution to the Sun's total luminosity. Using the regression line of Harris *et al.*, we find that the Sun should have a genic energy luminosity of $0.58 \pm 0.16\ L_\odot$. This value essentially coincides with $0.54 \pm 0.13\ L_\odot$, the amount unaccounted for by the Kamiokande-II solar neutrino experiment, and lies within about one standard deviation of $0.75 \pm 0.12\ L_\odot$, the amount unaccounted for by the ^{37}Cl solar neutrino experiment.

The gap between the upper and lower mass luminosity relations would represent the contribution from fusion that would generate an increasingly large share of the total radiated energy at higher masses. Standard fusion models predict that nuclear burning should begin at around 0.08 $M_\odot$($L > 5 \times 10^{-4} L_\odot$).[26] The genic energy scenario instead implies that nuclear burning begins to make a noticeable contribution only above 0.45 $M_\odot$($L \sim 0.07\ L_\odot$), where the lower main sequence bends upward to form the upper main sequence. This inflection point could also mark the point at which heat transport changes from a predominantly convective process to a predominantly radiative process. Current theoretical models place this transition point at around 0.35 $M_\odot$, the radiative core being entirely absent in a 0.3 $M_\odot$ star and comprising about 70% of the stellar mass in a 0.4 $M_\odot$ star.[10] By admitting a secondary power source such as genic energy, this transition point would be pushed toward higher masses, closer to the 0.45 $M_\odot$ inflection point.[27] This would close the gap between theory and observation in regards to the 0.45 $M_\odot$ transition point. In such a case the change from lower main sequence genic energy production to upper main sequence genic-plus-fusion energy production could be the critical perturbation that initiates the formation of a star's radiative core.

If the power source for lower main sequence stars is primarily non-nuclear, with fusion kicking in at the transition point from the lower to the upper main sequence, then the stellar luminosity function would be expected to have a bimodal shape. In fact, such is found to be the case. As seen in Fig. 3[28] the function's downward trend at higher luminosities is interrupted by an inflection at 0.07 $L_\odot$, the same point at which the mass-luminosity relation makes its upward bend. With fusion energy coming on line at this transition point as a macroscopic process, the star's luminosity would be boosted to a higher level. As a result, an increased number of stars would populate the luminosity category immediately above critical point, thereby forming a secondary lobe in the luminosity function. The upper main sequence stars composing this secondary lobe would be distinguished from those of the primary lobe in that they would be powered by two energy sources rather than one.

Genic energy could also be powering white dwarfs. Conventional theory suggests that these objects derive their energy from heat stored up during their main sequence nuclear-burning phase. However, the observed absence of degenerate dwarfs with luminosities less than $10^{-5}\ L_\odot$ suggests that some non-nuclear energy source other than stored heat must be powering

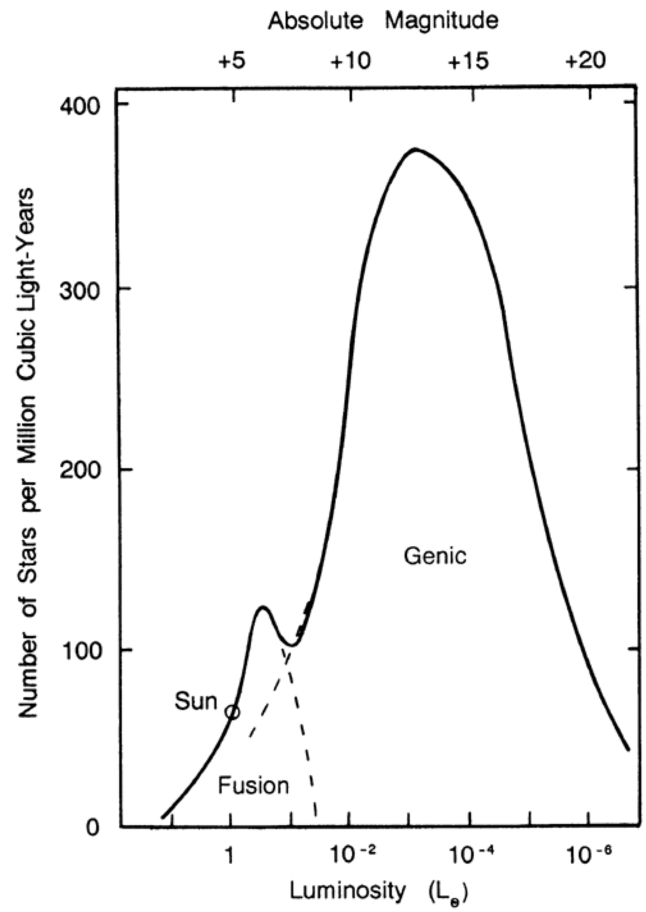

Figure 3. The luminosity function for stars in our galaxy. The profile charts the prevalence of stars in each of a series of consecutive luminosity increments.

them. Freese[29] has suggested that monopole-catalyzed nucleon decay may be the mystery energy source. Such a hypothetical process is unnecessary with the genic energy mechanism of subquantum kinetics, which adequately accounts for their outputs.

6. MODELED GENIC ENERGY OUTPUTS

The intrinsic genic energy luminosities of the planets would deviate by varying amounts from the lower main sequence mass-luminosity relation due to individual differences in $\bar{C}$, $\bar{\rho}$, and $\bar{T}$ for each planet, where $\bar{\rho}$ is the planet's average mass density. Gravitational potential, ϕ_g, would also be figured differently for the planets. In the case of lower main sequence stars, gravity potential would be determined primarily by the star's intrinsic mass, whereas in the low-mass planetary regime, external gravitational potential sources such as the Sun and galactic disk would begin making significant contributions.

Equations (7) may be used to estimate a body's genic energy luminosity L_g, knowing its mass M, average amplification coefficient $\bar{\mu}$, average specific heat $\bar{C}$, and average temperature $\bar{T}$. The values adopted for these parameters as well as the derived L_g values and observed intrinsic luminosities, L_i, are presented in Table II for the Sun and planets, and for the white dwarf Sirius B. The L_g values given here, being based on average density and temperature values, are only approximations, since a body's density and temperature vary considerably with radial distance.

Table II: Modeling Parameters and Intrinsic Luminosities for the Sun, Planets, and Sirius B.

Planet	M (g)	R (cm)	ϕ_0 (cm^2/s^2)	ϕ_{sun} (cm^2/s^2)	ϕ_{gal} (cm^2/s^2)	ϕ_g (cm^2/s^2)	$\bar{\mu}$ (s^{-1})	$\bar{C}$ (erg/g/°K)	$\bar{T}$ (°K)	L_g (erg/s)	L_i (erg/s)
Sun	1.99(33)	6.96(10)	−1.91(15)	...	−2.0(13)	−9.57(15)	5.00(−16)	2.09 ± 0.8(8)	9.5 ± 3(6)	2.0 ± 1.2(33)	3.9 (33)
Mercury	3.30(26)	2.44(8)	−9.00(10)	−2.21(13)	−2.0(13)	−4.23(13)	2.21(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	1.8 ± 1.1(19)	
Venus	4.87(27)	6.05(8)	−5.37(11)	−1.19(13)	−2.0(13)	−3.30(13)	1.72(−18)	1.26 ± 0.5(7)	2.5 ± 1(3)	2.7 ± 1.5(20)	
Earth	5.98(27)	6.38(8)	−6.25(11)	−8.54(12)	−2.0(13)	−2.98(13)	1.56(−18)	1.26 ± 0.5(7)	2.5 ± 1(3)	2.9 ± 1.6(20)	4.0 ± 0.2 (20)
Moon	7.35(25)	1.74(8)	−2.81(10)	−8.54(12)	−2.0(13)	−2.86(13)	1.50(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	2.8 ± 1.8(18)	7.0 ± 0.5 (18)
Mars	6.44(26)	3.39(8)	−1.27(11)	−5.64(12)	−2.0(13)	−2.58(13)	1.35(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	2.2 ± 1.4(19)	
Jupiter	1.90(30)	6.92(9)	−1.83(13)	−1.65(12)	−2.0(13)	−5.83(13)	3.05(−18)	1.18 ± 0.5(8)	9.0 ± 5(3)	6.2 ± 4.0(24)	3.4 ± 0.3 (24)
Saturn	5.69(29)	5.73(9)	−6.54(12)	−9.00(11)	−2.0(13)	−3.40(13)	1.77(−18)	8.1 ± 3.0(7)	6.0 ± 3(3)	4.9 ± 3.0(23)	8.6 ± 0.1 (23)
Uranus	8.74(28)	2.57(9)	−2.27(12)	−4.47(11)	−2.0(13)	−2.50(13)	1.31(−18)	3.8 ± 1.5(7)	4.0 ± 2(3)	1.7 ± 1.1(22)	0.3 ± 0.4 (22)
Neptune	1.03(29)	2.53(9)	−2.78(12)	−2.85(11)	−2.0(13)	−2.58(13)	1.35(−18)	3.6 ± 1.5(7)	4.0 ± 2(3)	2.0 ± 1.3(22)	3.3 ± 0.4 (22)
Pluto	6.6 (26)	2.90(8)	−1.52(11)	−2.17(11)	−2.0(13)	−2.05(13)	1.07(−18)	1.26 ± 0.5(7)	2.0 ± 1(3)	1.8 ± 0.7(19)	
Sirius B	2.1 (33)	5.0 (8)	−2.7 (17)	−7.0 (11)	−2.0(13)	−5.4 (17)	2.8 (−14)	3.0 ± 1.5(6)	2.0 ± 1(7)	3.6 ± 2.4(33)	0.4 – 10^3 (33)

The values for the model parameters are determined as follows. For all celestial bodies considered here, the gravity potential is calculated relative to a background value of $\phi_{gal} = (-2 \times 10^{13} - \phi_{gc})$ $cm^2 \cdot s^{-2}$, which includes the gravity potential contribution of the galaxy, galactic cluster, and supercluster. The value ϕ_{gc}, which is of the order of 6×10^{13} cm^2 s^{-2}, cancels out when L_g is calculated; see Eq. (7). The average internal gravity potential ϕ_g for the Sun is estimated to be five times its surface potential, $5\phi_0$, plus ϕ_{gal}, where $\phi_0 = -M_{\odot}k_g/R_{\odot}$. The internal gravity potentials for the planets, including the Earth and Moon, are calculated as $\phi_g = 2\phi_0 + \phi_{sun} + \phi_{gal}$, where $\phi_{sun} = -M_{\odot}k_g/r$ represents the contribution from the Sun's gravity potential field at the planet's heliocentric distance r. The individual gravity field contributions for the planets, $2\phi_0$, are about 2 1/2 times smaller than that for the Sun, since the planets have comparably smaller density gradients. Note that ϕ_g values for the planets are dominated primarily by the galactic component. In the case of Sirius B the potential is calculated to be $\phi_g \sim 2\phi_0$.

The values for $\bar{\mu}$ are calculated as $\bar{\mu} = \alpha\phi_g$, with $\alpha = 5.23 \times 10^{-32}$ $s \cdot cm^{-2}$. The value for α is chosen such that the calculated genic energy luminosity for the Sun is normalized to 0.51 $L_{\odot}$, accounting for two-thirds of the missing amount, as determined from solar neutrino observations.

Values adopted for the average specific heats assume compositions[20,23] and Boltzmann constant coefficient values[17,30] listed in Table III. The specific heats for the minor planets are taken to be equal to that of rock, 0.3 ± 0.1 cal/g/K.[31] The estimate for Sirius B assumes 2.0 k_B per heavy particle and an average of 57 amu per particle, predominantly an iron composition.

The average internal temperature of the Sun $\bar{T} \sim 9.5 \times 10^6$ K is estimated on the basis of a solar core temperature of $\sim 15 \times 10^6$ K. The temperature given for the Earth is consistent with current thermal structure models for its interior.[32] Temperatures for the Moon and minor planets have been chosen to be in this same neighborhood. The temperature ranges listed for Jupiter and Saturn are consistent with model core temperatures which range from 7200 K to 24 000 K for Jupiter and from 5500 K to 15 000 K for Saturn.[18,33] The average values listed for Uranus and Neptune are consistent with model core temperatures of 6900 K and 7100 K, respectively.[24] The uncertainties in knowing the core temperatures for these planets are comparable to those for Jupiter and Saturn. The average temperature chosen for Sirius B is consistent with a temperature of 2×10^7 K normally modeled for its core.

The luminosities predicted for Jupiter and Neptune are sufficient to account for all of their observed intrinsic heat flux. While those modeled for Saturn and Uranus fall somewhat below the observed values, they are reasonably close given the uncertainties in knowing the model parameters. The value predicted for Sirius B falls in the range of the dwarf's bolometric luminosity, which is not currently known with certainty. The soft x-ray luminosity of its corona is estimated to exceed 0.2 $L_{\odot}$ and could even be as high as 10^3 $L_{\odot}$.[34] The luminosity modeled for the Moon accounts for about 40% of the observed lunar thermal flux. The remaining 60% may reasonably be attributed to radioactive decay.

The genic energy luminosity predicted for the Earth is computed to be about 73% of the total terrestrial thermal flux, the remaining 27% being attributed to the radioactive decay of uranium, thorium, and potassium in the crust and mantle. Ganapathy and Anders[35] estimate that as much as 60% is contributed by radioactive decay. However, due to the uncertainty in estimating the uranium content of the Earth's crust, such estimates of the radiothermal contribution could be in error by at least a factor of two.[36] The portion of the total terrestrial heat flux that is unaccounted for by crustal radioactivity is believed to come from the Earth's core and is also thought to be responsible for driving convective processes that produce the Earth's magnetic field.[37] A variety of mechanisms has been suggested in the past to account for this nonfission fraction: trapped primordial heat, latent heat released as a result of the progressive growth of the Earth's solid inner core, gravitational convection induced by the preferential removal of dense alloys form the outer core during inner core crystalization, and radioactive decay of ^{40}k.[36,38] The photon energy dilation mechanism proposed here would be one other alternative to consider.

7. CONCLUDING REMARKS

In overview, it is seen that a variety of energy generation mechanisms has

Table III: Compositions Modeled for the Sun and Planets.

	Sun	*Jupiter*	*Saturn*	*Uranus*	*Neptune*	*Minor Planets*	k_B *per Heavy part*
Hydrogen							
Molecular		12%	55%	9%	5%		1.0
Metalic		61.5%	16%				2.0
Ionized	75%						3.0
Helium							
Atomic		3%	2%	2%	1%		1.0
Metalic		14.5%	7%				2.0
Ionized	25%						4.5
Water				65%	68%		
Rock				24%	25%	100%	
Rock and ice		9%	20%				

been proposed to account for the intrinsic luminosities of the heavy planets. However, none of these specifically explain why the planets lie so close to the stellar mass-luminosity relation. The genic energy hypothesis has the advantage that it can account for the observed planetary-stellar association in a relatively simple fashion. If the genic energy hypothesis is correct, then the mass-luminosity values for "brown dwarfs" in the luminosity range $10^{-9}\ L_\odot - 10^{-5}\ L_\odot$ should be found to coincide with the lower main sequence stellar relation.

Genic energy could also explain the high luminosities of x-ray and γ-ray emitting objects such as Cyg X−1 and Cyg X−3 and dwarfs such as AM Herculis objects, which are known to have x-ray luminosities ranging up to $10^4\ L_\odot$. This energy source could also account for the prodigious cosmic ray energy fluxes radiated by active galactic nuclei. Moreover, since this energy production mechanism is nonlinear and has the ability to function in an explosive mode, it serves as a good candidate energy source for powering novas, supernovas, and galactic core explosions.[5] Genic-energy-powered supernovas would be expected to develop from a hot blue supergiant stellar phase, rather than from a cool red supergiant phase, which is consistent with the discovery that the progenitor of supernovas SN1987 was a blue supergiant star.

Future observations providing mass-luminosity data on low luminosity dwarf stars ($10^{-9}\ L_\odot - 10^{-3}\ L_\odot$) should allow a key prediction of the genic energy hypothesis to be checked. Moreover, using presently available technology, it should be possible to directly test the energy dilation hypothesis by transponding hydrogen maser signals between widely separated spacecraft and searching for the presence of a non-Doppler blueshift component in the transponded signals.[5]

Acknowledgment
I would like to thank Fred G. LaViolette, George G. Lendaris, Lorne A. Nelson, and André K.T. Assis for their helpful comments. This paper is dedicated to the memory of my grandmother Maria Voutsadakis (1893–1985), whose example inspired me to continue even in the face of adversity.

Received 30 July 1991.

Résumé
Les coordonnées masse-luminosité pour les planètes de Jupiter se trouvent le long de la relation inférieure de la succession stellaire principale masse-luminosité, qui suggère que les planètes et les étoiles naines rouges sont actionnées par un source semblable d'énergie non-nucléaire. Ces découvertes confirment une prévision de la cinétique subquantique que les corps célestes produisent de l'énergie "genique" à cause du déplacement non-Doppler vers le bleu des photons à un taux qui dépend de la valeur du potentiel gravitationnel local. L'énergie genique rend compte aussi de 40% du flux thermal de la lune, de tout le flux thermal intérieur de la terre, et pour plus de la moitié de la luminosité du soleil, ce qui resout le mystère du flux fiable des neutrinos solaires. La courbure ascendante dans la masse-luminosité relation et la inflexion de la fonction de luminosité à 0.45 $M_\odot$ *sont attribuées au commencement de la combustion nucléaire, les réactions de fusion ignitant à une masse stellaire plus grande que l'on avait précédemment supposée.*

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Paul A. LaViolette
The Starburst Foundation
1176 Hedgewood Lane
Schenectady, New York 12309 U.S.A.

current address: 6369 Beryl Road, #104
Alexandria, VA 22312
email: Gravitics1@aol.com