Stellar accretion and associated processes: perspectives from kinetic theory and thermodynamics[a]

Stephen J. Crothers
sjcrothers@plasmaresources.com

Abstract: Temperature and the laws of thermodynamics are central to physics. They serve to guide all theory that involves thermodynamic relations. Temperature, irrespective of global or local equilibrium conditions, must always be intensive to satisfy the 0th and 2nd laws of thermodynamics. At the same time, if the laws of thermodynamics are to be followed, not only must the units balance on each side of a thermodynamic equation but so too must thermodynamic character. The theory of protostar formation by gravitational collapse is constructed from the kinetic theory of an ideal gas. In this instance, temperature is introduced in combination with gravitation via the virial theorem. Such an approach assumes that an uncontained cloud of gas in interstellar space will gravitationally collapse, or self-compress, when sufficiently massive. Yet, experiments demonstrate that uncontained gases, irrespective of bulk mass, always expand into their surroundings. The critical mass for initiation of self-compression of a gas is the Jeans mass, which depends on the gas temperature. Similarly, stellar accretion and accretion disk relations involve temperature. All these expressions assign temperature a nonintensive character, in violation of the laws of thermodynamics. Consequently, the relations and the theories from which they are derived are invalid.

Key words: Semidetached binaries; accretion disk; white dwarf binary; black hole binary; neuron star binary; cataclysmic variables; dwarf novae; Eddington limit; Jeans mass; Chandrasekhar limit; standard candles.

I. INTRODUCTION

"Astrophysicists are in the unique position that they have no fundamental field of study of their own, but must adapt a variety of basic physical principles in a nontrivial manner to the astronomical environment."[1] Accordingly, in order to properly ascertain astrophysical reality, it is essential that the balance of thermodynamic character be preserved in all thermodynamic mathematical relations.[2] Landsberg argued that this requirement should be regarded as the Fourth Law of thermodynamics.[3,4] Similarly, Canagaratna[5] noted that "if one side of an equation is extensive (or intensive), then so must be the other side." Landsberg stated the 'Fourth Law' in this way: for a class of non-equilibrium states, and for equilibrium states, extensive and intensive properties exist. Furthermore, the laws of thermodynamics hold wherever local thermodynamic equilibrium is utilized.[3,6]

That an uncontained cloud of gas in interstellar space can self-compress through gravitationally collapse when sufficiently massive is an assumption that has no foundation in experiment. It is well known from experimental physics and chemistry that

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all gases when released from containment always expand: "a gas expands spontaneously to fill its container. Consequently, insofar as the kinetic theory of gases is concerned, the volume of a gas equals the volume of the container in which it is held."[7] All experiments attest that gases can only be compressed by the action of an external agent acting in the presence of real surfaces. An uncontained gas does not possess a real surface and a supposed force of gravity between the particles of an ideal gas is not an external agent. The kinetic theory of an ideal gas is defined in the presence of a container[8-10] without which pressure, temperature, volume and density of the gas cannot be defined in accordance with the ideal gas equation $PV = nRT$, which is thermodynamically balanced. Moreover, there are no forces between the particles of an ideal gas except when they collide elastically with one another and with the walls of their container.[11, 12] The pressure of a gas is due to the collision of the gas particles with the walls of its container, as there is no net effect of collisions between particles other than transfer of this pressure.[13-15] The introduction of gravitational forces between ideal gas particles to facilitate self-compression and form protostars stands in violation of the kinetic theory itself. Additionally, the theory of formation of protostars by self-compression of an ideal gas dispenses with the setting of containment and the requirement of thermodynamic balance in related equations. Similarly, the theories of stellar accretion and accretion disks, also obtained using the kinetic theory of an ideal gas and the virial theorem, dispense with the gas container and thermodynamic balance. Both the kinetic theory of an ideal gas and the laws of thermodynamics are violated by these theories, so they are invalid. By way of introductory example, the astronomers assign Coulomb potential energy a temperature. For instance, according to Frank, King and Raine,[16] when two charged particles collide and are deflected by ~ 90^{o} with respect to a frame of reference moving with the center-of-mass of the two particles, "such that the kinetic and potential energies of the particles are comparable at closest approach,

$$\frac{e_1 e_2}{[4\pi\varepsilon_o]b_o} \sim \frac{1}{2}mv^2 \sim kT \tag{1}$$

for thermal particles".[16] In this expression, b_o is the impact parameter and m is the reduced mass of the two colliding charged particles. The kinetic energy term in the center serves simply as a conduit to assign the temperature of an ideal gas to the left side of Eq. (1). Dividing through by kT gives,

$$\frac{e_1 e_2}{[4\pi\varepsilon_o]b_o kT} = 1\,. \tag{2}$$

Squaring Eq. (2) gives,

$$1 = \frac{e_1^2 e_2^2}{[4\pi\varepsilon_o]^2\, b_o^2 (kT)^2}\,. \tag{3}$$

Multiplying through by πb_o^2 , "[i]n an atomic or molecular gas, b_o would measure the size of the gas particles, and give a cross-section"[16],

$$\sigma_\perp = \frac{\pi e_1^2 e_2^2}{[4\pi\varepsilon_o]^2 (kT)^2}\,. \tag{4}$$

If the gas particle density is N, "the mean free path $\lambda_\perp$ between such collisions would then be"[16],

$$\lambda_\perp = \frac{1}{N\sigma_\perp} = \frac{[4\pi\varepsilon_o]^2}{\pi N}\left(\frac{kT}{e_1 e_2}\right)^2. \tag{5}$$

Equation (1) applies the ideal gas law to charged particles whereas ideal gas particles have no charge. Furthermore, Eq. (1) assigns a temperature to Coulomb potential energy; but potential energy has no temperature. It is improper to link potential energy to kinetic energy in order to obtain a temperature which can have no physical meaning in this context. Equations (1) to (5) are therefore invalid.

II. THE VIRIAL THEOREM AND GRAVITATIONAL COLLAPSE

The virial theorem states that the kinetic energy K and gravitational potential energy U of an equilibrated, stable, gravitationally bound system, satisfies this equation,

$$2K + U = 0. \tag{6}$$

According to Chandrasekhar, "[t]he virial theorem applies to a wide variety of systems, from an ideal gas to a cluster of galaxies."[17] But in reality, ideal gases are never gravitationally bound, and this supposition should never have been made by Chandrasekhar. In any case, the Standard Model asserts that stars are formed by gravitational collapse, i.e. self-compression, of an uncontained cloud of gas in interstellar space. The Standard Model further assumes that the gas cloud can be treated as an ideal gas and so the virial theorem is then improperly applied to the ideal gas. "The gravitational potential energy of a spherical cloud of constant density is approximately"[18],

$$U \approx -\frac{3}{5}\frac{GM_c^2}{R_c}. \tag{7}$$

Using the total kinetic energy of a contained system of ideal gas particles, astronomy introduces temperature into Eq. (6)[18],

$$K = \frac{3}{2}NkT. \tag{8}$$

Since the gas is ideal the use of Eq. (7) violates the kinetic theory because there are no forces between the particles of an ideal gas except when they collide elastically with one another and with the walls of their container. Because there are gravitational forces and no container Eq. (7) therefore does not exist for an ideal gas. If Eq. (7) is argued for a gas that is not ideal then combining it with Eq. (8) in the virial theorem again violates the kinetic theory by introducing a contradiction. Yet from these very equations the Jeans mass, critical for initiation of 'gravitational collapse' of an uncontained cloud of ideal gas in outer space, is derived by astronomers. Now $N = M_c/\mu m_H$ is the number of gas particles, where μ is the mean molecular weight, m_H the mass of the hydrogen atom and M_c the mass of the proposed gas cloud. The condition for self-compression is then, using Eqs. (7) and (8) in Eq. (6)[18],

$$\frac{3M_c kT}{\mu m_H} < \frac{3}{5}\frac{GM_c^2}{R_c} \quad . \tag{9}$$

Solving for temperature of the gas cloud[18],

$$T < \frac{1}{5k}\frac{GM_c \mu m_H}{R_c} \quad . \tag{10}$$

Temperature on the left side of inequality (10) is intensive but the quotient M_c/R_c, which determines the thermodynamic character of the right side, is not intensive: the left side is homogenous function of degree 0 but the right side is homogenous function of degree ⅔. Consequently inequalities (9) and (10) violate the 0^{th} and 2^{nd} laws of thermodynamics and are therefore inadmissible. Furthermore, inequality (10) assigns temperature to gravitational potential energy: but gravitational potential energy does not have a temperature and cannot contribute to the temperature in any context. The assumption that gravity and the ideal gas, expressed by Eqs. (7) and (8) respectively, can be combined in Eq. (6), is false. Nonetheless, astronomy and astrophysics mistakenly combine them in the construction of their theories. Eddington, for example, asserted that "[w]e shall consider the equilibrium of an isolated mass of gas held together by its own gravitational attraction. … We shall have to consider particularly stars composed of a perfect gas. The temperature is then determined from P and ρ by the gas equation."[19] He then advanced for stellar temperatures, in similar fashion to inequality (10),

$$T = \frac{\beta\mu}{(n+1)\Re}\phi , \tag{11}$$

where β is the quotient of the gas pressure to the total pressure, μ the molecular weight in terms of the hydrogen atom, n is a disposable constant, $\Re$ is the universal gas constant and ϕ the gravitational potential. Once more, Eq. (11) is false because it assigns temperature to gravitational potential. Furthermore, the left side of Eq. (11) is intensive but the right side is not. As a result, this expression is again inadmissible.

Similarly, Chandrasekhar asserted that "[f]or a cloud of density so low that the ideal gas laws may be assumed to hold, all forces except the gravitational forces may be neglected."[18] For stellar interiors, he then advanced for the mean temperature $\overline{T}$ of "a gaseous configuration in equilibrium in which the radiation pressure is negligible"[17],

$$\overline{T} > \frac{1}{6k}\frac{G\mu HM}{R} . \tag{12}$$

Here H is the proton mass. Again, temperature on the left side of inequality (12) is intensive but the quotient M/R, which determines the thermodynamic character of the right side, is not intensive. Also note that Chandrasekhar assigns a temperature to gravitational potential energy when, in fact, it cannot contribute to temperature.

If ρ_o is the constant initial density of the supposed uncontained spherical ideal gas cloud and V its volume, assuming for the sake of argument that ρ_o and V of a gas can be defined in the absence of a container, then the mass of that cloud is,

$$M_c = V\rho_o = \frac{4}{3}\pi R_c^3 \rho_o . \tag{13}$$

Solving this equation for the cloud radius R_c and substituting into inequality (9), with rearrangement for the cloud mass M_c, the Jeans criterion for gravitational collapse of the hypothesised gas cloud is obtained[18],

$$M_c > \left(\frac{3}{4\pi\rho_o}\right)^{1/2}\left(\frac{5kT}{G\mu m_H}\right)^{3/2} . \tag{14}$$

The right side of this inequality is the Jeans mass M_J [18],

$$M_J = \left(\frac{3}{4\pi\rho_o}\right)^{1/2}\left(\frac{5kT}{G\mu m_H}\right)^{3/2} . \tag{15}$$

Mass on the left side of Eq. (15) is extensive. The thermodynamic character of the right side is determined by the temperature and the constant initial density which are both intensive. All other terms are either pure numbers or physical constants and thereby have no thermodynamic character. Since T and ρ_o are intensive so too is $T^{3/2}/\rho_o^{1/2}$, making the right side intensive. Consequently Eq. (15) is thermodynamically unbalanced and invalid. Robitaille[20] has also noted the invalidity of the Jeans mass.

The Jeans criterion can be expressed in terms of the radius of the supposed gas cloud. Substituting M_c from Eq. (13) into inequality (9), with rearrangement for radius, gives the critical radius R_J for initiation of self-compression of the gas cloud[18],

$$R_J = \left(\frac{15kT}{4\pi\mu m_H G\rho_o}\right)^{1/2} . \tag{16}$$

The critical 'Jeans length' R_J on the left side is not intensive (homogenous function of degree ⅓) whereas the right side is intensive (homogenous function of degree 0). Hence Eq. (16) is inadmissible.

The theory of gravitational collapse of an uncontained cloud of gas in outer space is untenable due to inherent violations of both the kinetic theory of gases and the laws of thermodynamics. The Jeans mass and the Jeans length therefore have no scientific credibility. Everything deduced from these relations, which is quite vast in the literature, is therefore invalid.

III. SPHERICALLY SYMMETRIC ACCRETION

Mass, being extensive, is additive, a homogeneous function of degree 1: the mass of a system is the sum of the masses of its parts,

$$M = \sum_{i=1}^{n} m_i \ . \tag{17}$$

Hence,

$$\frac{dM}{dt} = \sum_{i=1}^{n} \frac{dm_i}{dt} \ , \tag{18}$$

the rate of change of the mass of a system is the sum of the rates of change of the masses of its parts so that *dM*/*dt* is also extensive. The extensivity of *dM*/*dt* also results from differentiating Eq. (13). The rate of change of mass with respect to time is often denoted by $\dot{M}$.

For fully ionised hydrogen gas the net inward force on an electron-proton pair is the difference between the inward gravitational force and the outward radiation force and is said to be[16],

$$F_{in} = \left(GMm_p - \frac{L\sigma_T}{4\pi c} \right) \frac{1}{r^2} \ , \tag{19}$$

where M is the mass of the accreting source (assumed to mainly hydrogen gas and fully ionised), m_p is the proton mass (since $m_p + m_e \cong m_p$), L the luminosity of the accreting source, r the radial distance, c the speed of light and σ_T the Thomson cross-section. This expression vanishes for the Eddington limit luminosity[16], hence,

$$L_{Ed} = \frac{4\pi c GMm_p}{\sigma_T} \ . \tag{20}$$

Equation (19) inadmissibly combines gravity with the kinetic theory of an ideal gas so that gases exert gravitational forces on gases: "Astrophysical gases, other than the degenerate gases in white dwarfs and neutron stars and the cores of 'normal stars', have as equation of state the *perfect gas law:* $P = \rho kT / \mu m_H$."[18] Gases however, are not gravitationally bound within themselves or to other gases. Hence Eq. (20) is also invalid. Furthermore, Eddington's mass-luminosity relation[19] is itself invalid for violation of the laws of thermodynamics.[21] In terms of the Rosseland mean opacity $\bar{\kappa}$, the Eddington limit is[16],

$$L_{Ed} = \frac{4\pi c GM}{\bar{\kappa}} \ . \tag{21}$$

Equation (21) is inadmissible because whatever form the Eddington limit takes it is necessarily invalid[21], yet it appears widely in astrophysical theory.

Where all the kinetic energy of infalling matter becomes radiation at the star's surface, the accretion luminosity is[16, 18],

$$L_{acc} = \frac{GM\dot{M}}{R_*}, \tag{22}$$

where R_* is the stellar radius. Setting Eq. (22) equal to Eq. (20) astrophysics derives a maximum possible steady accretion rate[16],

$$\dot{M} = \frac{4\pi c m_p R_*}{\sigma_T}. \tag{23}$$

Equation (23) is invalid since Eq. (20) is invalid. Equation (22) is also invalid for violation of the Stefan-Boltzmann law, proven in detail in section **VIII** below.

Equation (22) is employed for the event horizon of a black hole at the so-called Schwarzschild radius[b] $R_* = 2GM/c^2$ to give[16],

$$L_{acc(BH)} = \frac{2\eta GM\dot{M}}{R_*} = \eta\dot{M}c^2, \tag{24}$$

where η is the efficiency. Applying the Stefan-Boltzmann law to the foregoing luminosities, various temperatures have been determined.[16] If the accretion luminosity is radiated as a blackbody, then, by the Stefan-Boltzmann law,

$$L_{acc} = \sigma 4\pi R_*^2 T^4, \tag{25}$$

so the blackbody temperature $T \equiv T_b$ is[16],

$$T_b = \left(\frac{L_{acc}}{4\pi\sigma R_*^2}\right)^{1/4}. \tag{26}$$

If the Eddington limit is emitted as a blackbody spectrum, then, $L_{Ed} = \sigma 4\pi R_*^2 T^4$, from which the Eddington temperature $T \equiv T_{Ed}$ is[16],

$$T_{Ed} = \left(\frac{L_{Ed}}{4\pi R_*^2 \sigma}\right)^{1/4} = \left(\frac{GMm_p c}{\sigma_T \sigma R_*^2}\right)^{1/4}, \tag{27}$$

by using Eq. (20). The far-right side of Eq. (27) is not intensive whereas the left side is intensive, thereby violating the thermodynamic character of temperature. Hence Eq. (27) is false. Furthermore, by Eq. (25) for the Stefan-Boltzmann law, luminosity is a homogenous function of degree ⅔. However, Eqs. (20) and (21), incorrectly equate luminosity to a homogeneous function of degree 1, since mass is always extensive. This constitutes a violation of the Stefan-Boltzmann law. Consequently, equations (19) through to (24) are all invalid.

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[b] Also called the ‘gravitational radius’.

A ‘thermal temperature’ is also advanced for each proton-electron pair accreted. In this case gravitational potential energy released at the surface of the compact object is said to be[16],

$$U = \frac{GM\left(m_p + m_e\right)}{R} \sim \frac{GMm_p}{R}. \tag{28}$$

where R is the stellar radius. The combined thermal energy of the proton and electron is claimed to be $3kT$.[16] Equating $3kT$ to Eq. (28) and solving for the thermal temperature $T \equiv T_{th}$ gives[16],

$$T_{th} = \frac{1}{3k}\frac{GMm_p}{R}. \tag{29}$$

The right side of Eq. (29) is not intensive thereby violating the thermodynamic character of temperature, so the equation is false. Furthermore, although gravitational potential energy has no temperature, Eq. (29) assigns temperature to gravitational potential energy. A similar relation is advanced for the temperature of a post-shock wave ideal gas. The post-shock temperature T_{ps} is[22],

$$T_{ps} = \frac{3}{16}\frac{\mu m_H}{k}v_i^2, \tag{30}$$

where v_i is the speed of the gas flowing into the shock front. Gravity is then introduced into Eq. (30) by setting $v_i = \sqrt{2GM/R_*}$, the ‘free-fall speed’, where R_* is the stellar radius, to yield[22],

$$T_{ps} = \frac{3}{8k}\frac{GM\mu m_H}{R_*}. \tag{31}$$

Equation (31) for the shock temperature of an optically thin ideal gas accreting onto the star is invalid since the right side of the equation is not intensive. And once again, potential energy is assigned a temperature when in reality potential energy has no temperature and cannot contribute to temperature. Consequently, the theory of shock heating of accreting gas is false.

For adiabatic gas inflow the accretion rate is given by[22],

$$\dot{M} = \alpha\rho cR_g^2\left(\frac{\mu m_H c^2}{kT}\right)^{3/2}, \tag{32}$$

where the ‘Schwarzschild radius’ $R_g = 2GM/c^2$, α is an adjustable numerical coefficient such that $0.3 \le \alpha \le 1.5$ and all terms are evaluated at the critical radius. Substituting the so-called ‘Schwarzschild radius’ R_g into Eq. (32) and rearranging for T gives[22],

$$T = \left(\frac{16\alpha\rho^2 G^4 M^4 \mu^3 m_H^3}{k^3 \dot{M}^2} \right)^{1/3} . \tag{33}$$

Once again it is clear that the left side of this equation is intensive but the right side is not. Equations (32) and (33) are therefore inadmissible.

"The star's gravitational pull seriously influences the gas's behaviour only inside the accretion radius r_{acc}"[16], which is given by,

$$r_{acc} = \frac{2GM}{c_s(\infty)^2} \cong 3\times10^{14} \left(\frac{M}{M_\Theta} \right) \left(\frac{10^4 K}{T(\infty)} \right) \text{cm}, \tag{34}$$

where $c_s(\infty)$ is the ambient speed of sound in the gas far from the star, K denotes Kelvin units for absolute temperature and $T_s(\infty)$ is the ambient absolute temperature of the gas far from the star. The accretion radius on the left side is not extensive but the far right side of Eq. (34) is extensive and as a result, this expression is also invalid.

Furthermore, although Eq. (25) is valid for a blackbody, gases do not emit blackbody spectra. Only condensed matter can emit a blackbody spectrum because the production of a thermal spectrum requires a vibrational lattice, which no gas possesses.[23] Gases emit only in narrow bands and no amount of line broadening by any means will transform gas band emission spectra into a thermal spectrum. Additionally, not all condensed matter emits in the blackbody even though their spectra exhibit a Planckian distribution over frequencies (thermal spectra). This is because emissivities vary with substance.[24]

IV. CLOSE BINARY STAR SYSTEMS

According to the theory of gaseous stars, mass can be transferred from one star (the secondary) to another star (the primary) when one star expands to fill its Roche lobe. The Roche lobe is a gravitational equipotential. It is to be immediately noted that gas, which is not internally gravitationally bound, is here being bound by a gravitational equipotential so that "atmospheric gases can escape through the inner Lagrangian point L_1 to be drawn toward its companion."[18]

As a first approximation to the mass transfer rate for a semidetached binary the transfer portal is modelled by two identical spheres of radius R that overlap by a distance d,[15] where $d \ll R$. The cross-sectional area is circular and d lies on the overlap ends of the radius of each sphere, perpendicular to the cross-sectional area of the portal. The mass transfer rate for incompressible flow of the gas is[18],

$$\dot{M} = \rho \frac{dV}{dt} = \rho A \frac{dl}{dt} = \rho v A , \tag{35}$$

where A is the cross-sectional area, v the speed of the transfer gas flow and ρ is the gas density. Since $d \ll R$ the radius r of the circular portal is[18],

$$r = \sqrt{Rd}\ . \tag{36}$$

Hence,

$$\dot{M} = \rho v \pi R d\ . \tag{37}$$

For an ideal gas,

$$\frac{1}{2} m \bar{v^2} = \frac{3}{2} kT\ . \tag{38}$$

If the gas is hydrogen then $m = m_H$ then from Eq. (38),

$$v = v_{rms} = \sqrt{\bar{v^2}} = \sqrt{\frac{3kT}{m_H}}\ . \tag{39}$$

Substituting Eq. (39) into Eq. (37) the astronomers obtain[18],

$$\dot{M} = \pi R d \rho \sqrt{\frac{3kT}{m_H}}\ . \tag{40}$$

This equation is invalid for a number of reasons: First, it is extensive on the left side (a homogenous function of degree 1) but on the right side it is a homogenous function of degree ⅔ owing to the product *Rd* because *R* is a homogenous function of degree ⅓ and *d*, being a portion of *R*, is also a homogenous function of degree ⅓. Secondly, when two gases mix they do so by diffusion, not by gravitation between the particles. Thirdly, there are no gravitational forces between the particles of an ideal gas because there are no forces at all between the particles of an ideal gas except when they collide elastically with one another and with the walls of their container. The primary star, all but possibly its core, is also alleged to be an ideal gas. Fourthly, it is improper to use v_{rms} of the ideal gas for the speed of unidirectional gaseous mass transfer between stars because in the ideal gas the speeds of the gas particles are in all directions, not all in just one direction. One cannot therefore equate the mass transfer speed, which is in only one direction for all the particles, to the v_{rms} speed of the omnidirectional ideal gas particles by which the ideal gas temperature is defined, whether or not the gas transfer speed has the same magnitude of v_{rms}. Consider a container of gas at thermal equilibrium that is moving with a constant velocity $\vec{v}_c$. The speed $v_c = |\vec{v}_c|$ of the container of gas does not affect the temperature of the gas inside the container. Similarly, if the container of gas is accelerated or suspended within a gravitational field, the temperature of the gas inside the container is not affected.[10, 25] Equation (40) violates both the kinetic theory of an ideal gas and the 0th and 2nd laws of thermodynamics, so it is false.

V. ACCRETION DISKS IN CLOSE BINARY SYSTEMS

The steady state total disk luminosity via Roche lobe overflow is[16, 18, 26],

$$L_{disk} = \frac{GM\dot{M}}{2R_*} = \frac{1}{2} L_{acc}\ , \tag{41}$$

where R_* is the primary star radius and M is its mass. L_{acc} is invalid by Eq. (22) above, so Eq. (41) is also invalid.

The disk luminosity due to accretion in close binary systems is obtained from L_{acc} by rewriting the invalid Eq. (22) above in the alternative form[16],

$$L_{acc} = 1.3\times10^{36}\dot{M}_{16}\left(\frac{M}{M_{\Theta}}\right)\left(\frac{10(km)}{R_*}\right) \text{ erg s}^{-1}, \tag{42}$$

where M_{Θ} is the Sun's mass, $\dot{M}_{16} \approx 1$ for neutron stars or white dwarfs and 10 (km) denotes 10 kilometers.

Accretion disk temperature as a function of radial distance r of the annulus from the primary star of radius R and mass M is given by[18],

$$T = \left(\frac{GM\dot{M}}{8\pi\sigma R^3}\right)^{1/4}\left(\frac{R}{r}\right)^{3/4} = \left(\frac{GM\dot{M}}{8\pi\sigma r^3}\right)^{1/4}, \tag{43}$$

which is invalid because it is thermodynamically unbalanced. A subtlety arises here. The radius of a star relates to its volume and hence its mass, via density. Since mass is extensive so too is the volume. The stellar radius is therefore homogeneous degree ⅓. The radius of the accretion disk annulus relates to its area and hence its mass, via density, because the disk is modelled in terms of mass per unit area of the disk. Since mass is extensive so too is the disk area. The disk radius is therefore homogeneous degree ½. Consequently, the quotient R/r, although having no units, is homogeneous degree -1/6. The right side of Eq. (43) is therefore homogeneous degree 1/8, but the left side is homogeneous degree 0. The quotient R/r is thermodynamically incongruent due to the different definitions of density to which the radii R and r respectively apply.

Taking into account a supposed thin turbulent boundary layer Eq. (43) becomes[18],

$$T = \left(\frac{3GM\dot{M}}{8\pi\sigma R^3}\right)^{1/4}\left(\frac{R}{r}\right)^{3/4}\left(1-\sqrt{R/r}\right)^{1/4}, \tag{44}$$

which is also invalid for nonintensive temperature. Furthermore, $\left(1-\sqrt{R/r}\right)$ is thermodynamically incongruent because the number 1 has no thermodynamic character and $\sqrt{R/r}$ is a homogenous function of degree -1/12. Not only is the right side of Eq. (44) nonintensive it is also internally inconsistent thermodynamically. In any proposed thermodynamic relation, a quantity that has thermodynamic character cannot be added to or subtracted from a quantity that has a differing thermodynamic character, or lack of thermodynamics character as in the case of pure numbers and physical constants.

The characteristic disk temperature is[18],

$$T_{disc} = \left(\frac{3GM\dot{M}}{8\pi\sigma R^3}\right)^{1/4}, \tag{45}$$

and the maximum disk temperature is[18],

$$T_{\max} = 0.488\left(\frac{3GM\dot{M}}{8\pi\sigma R^3}\right)^{1/4}. \tag{46}$$

If $R \ll r$ then Eq. (44) reduces to,

$$T = \left(\frac{3GM\dot{M}}{8\pi\sigma R^3}\right)^{1/4}\left(\frac{R}{r}\right)^{3/4}. \tag{47}$$

Equations (45) through to Eq. (47) are all invalid for nonintensive temperature on the right side.

In the steady state, optically thick,[c] blackbody thin disk approximation the accreting mass is confined so close to the orbital plane that the disk mass transfer is modelled "as a two-dimensional gas flow".[16] In this model the disk temperature is dependent on radial position in the disk. It is given by[16],

$$T(R) = \left(\frac{3GM\dot{M}}{8\pi R^3\sigma}\right)^{1/4}\left(1-\sqrt{\frac{R_*}{R}}\right)^{1/4}, \tag{48}$$

where M is the mass of the star, R_* the radius of the star, R the annular radial position in the disk and $\dot{M}$ the mass transfer rate. The left side is intensive but the right side is both nonintensive and thermodynamically incongruent. Thus, Eq. (48) is invalid. If $R \gg R_*$ then Eq. (48) reduces to[16],

$$T(R) = \left(\frac{3GM\dot{M}}{8\pi R_*^3\sigma}\right)^{1/4}\left(\frac{R}{R_*}\right)^{-3/4}, \tag{49}$$

which is also invalid, by Eq. (45). Nonetheless, astronomers "approximate the spectrum emitted by each element of area of the disc as"[16],

$$I_\nu = B_\nu[T(R)] = \frac{2h\nu^3}{c^2\left(e^{h\nu/kT(R)}-1\right)}, \tag{50}$$

which is Planck's equation for blackbody spectra with T replaced by $T(R)$. Equation (50) is invalid because Eq. (49) is invalid. It is important to note that Planck's equation for thermal spectra applies only to blackbodies – it is not universal.[24]

[c] In the z-direction.

From Eq. (50) "the flux at frequency ν from the disc"[16] is given by[16],

$$F_\nu = \frac{4\pi h\nu^3 \cos i}{c^2 D^2} \int_{R_*}^{R_{out}} \frac{R dR}{e^{h\nu/kT(R)} - 1}, \tag{51}$$

where D is the distance of an observer with a line of sight angle i to the disk normal and R_{out} is the distal radius of the disk. Equation (51) imports the invalidity of Eq. (49) so it too is invalid.

The structure of thin steady α-disks[d] is described by a set of seven equations called the Shakura-Sunyaev disk solution. The Shakura-Sunyaev central temperature of the disk is given by[16],

$$T_c = 1.4\times10^4 \alpha^{-1/5} \dot{M}_{16}^{3/10} m_1^{1/4} R_{10}^{-3/4} f^{6/5}, \tag{52}$$

where α is a constant,[e] $\dot{M}_{16} = \dot{M}/10^{16}$ g·s^{-1}, $m_1 = M/M_\Theta$, $R_{10} = R/10^{10}$ cm and $f = \left[1 - \sqrt{R_*/R}\right]^{1/4}$. The left side of Eq. (52) is intensive but the right side is not intensive, and owing to f is, in addition, thermodynamically incongruent, thereby rendering it false. Deprived of a valid temperature relation the Shakura-Sunyaev disk solution has no scientific merit.

"[T]he scaleheight H of any region dominated by radiation pressure"[16] is given by,

$$H \cong \frac{3\sigma_T \dot{M}}{8\pi m_p c}\left[1 - \left(\frac{R_*}{R}\right)^{1/2}\right]. \tag{53}$$

Substituting L_{Ed} of Eq. (20) into Eq. (24) and solving for $\dot{M} \equiv \dot{M}_{crit}$ gives[16],

$$\dot{M}_{crit} = \frac{2\pi R_* m_p c}{\eta \sigma_T}. \tag{54}$$

Here η is the efficiency which has the value 0.1 for neutron stars and black holes[16]. Substituting Eq. (54) into Eq. (53) gives[16],

$$H \cong \frac{3R_* \dot{M}}{4\eta \dot{M}_{crit}}\left[1 - \left(\frac{R_*}{R}\right)^{1/2}\right], \tag{55}$$

from which the astronomers assert that,

> "[t]his equation shows that *at accretion rates $\dot{M}$ approaching $\dot{M}_{crit}$ the thin disc approximation must break down near the central object*. For η = 0.1 and

---

[d] The 'standard model'.

[e] The so-called 'α-prescription'.

$\dot{M} = \dot{M}_{crit}$ we find that $H/R = 1$ for $R = 2R_*$. Hence, for near-critical accretion rates, radiation pressure acts to make the innermost parts of the disc quasi-spherical. We note that this result is independent of viscosity …"[16]

However, Eq. (54) and Eq. (55) are invalid since Eqs. (20) and (24) are false. Consequently these conclusions of the astronomers are also false.

In the case of irradiated disks, assuming "that the central luminosity L derives entirely from accretion at the steady rate $\dot{M}$ on to a compact object of radius R_*"[16],

$$L \cong \frac{2GM\dot{M}}{R_*}. \tag{56}$$

Equation (56) is invalid in the very same fashion of Eq.(41).

If ψ is the quotient of the vertical viscosity to the radial viscosity, then[16],

$$L \geq 4\pi\psi\dot{M}c\sqrt{\frac{GM}{R}}. \tag{57}$$

Equating Eqs. (56) and (57) gives,

$$\frac{R}{R_*} \geq 8\pi^2\psi^2\frac{c^2R_*}{2GM}. \tag{58}$$

From Eq. (58) the astronomers determine various contexts of disk warping[16]. However, since Eq. (56) is invalid so too is Eq. (58).

V. BINARY ACCRETION FROM STELLAR WINDS

It is also advanced that accretion can occur onto a primary compact star from the stellar wind of a luminous early-type secondary star[16]. In the case of a neutron star primary, the accretion luminosity is given by[16],

$$L_{acc} \sim 10^{37}\left(\frac{\dot{M}}{-10^{-4}\dot{M}_w}\right)\left(\frac{-\dot{M}_w}{10^{-5}M_\Theta\, yr^{-1}}\right) \text{ erg s}^{-1}, \tag{59}$$

where $-\dot{M}_w$ is the mass-loss rate of the secondary by its solar wind. By the Stefan-Boltzmann law luminosity of a spherical body is a homogenous function of degree ⅔. The right side of Eq. (59) is a homogenous function of degree 1. Consequently Eq. (59) is inadmissible. Indeed, by the Stefan-Boltzmann law,

$$L_{acc} \sim 10^{37}\left(\frac{\dot{M}}{-10^{-4}\dot{M}_w}\right)\left(\frac{-\dot{M}_w}{10^{-5}M_\Theta\, yr^{-1}}\right) = \varepsilon\sigma AT^4. \tag{60}$$

Dividing through by the area A,

$$\frac{L_{acc}}{A} \sim \frac{10^{37}}{A}\left(\frac{\dot{M}}{-10^{-4}\dot{M}_w}\right)\left(\frac{-\dot{M}_w}{10^{-5}M_\Theta\, yr^{-1}}\right) = \varepsilon\sigma T^4 . \tag{61}$$

Luminosity divided by area is intensive. The collection of terms in the center of Eq. (61) is not intensive, so Eq. (59) is invalid. Note that luminosity is dependent upon the emissivity of the material. Astronomy and astrophysics always set $\varepsilon = 1$ for a blackbody, thereby neglecting the effects of emissivity, which varies with material.

V. DISK ACCRETION ONTO COMPACT OBJECTS

Where the accretion disk extends down to the surface of the accreting star the astronomers invoke a boundary layer. The Keplerian angular velocity Ω_K of the disk gas far from the boundary layer is[16],

$$\Omega_K(R) = \sqrt{\frac{GM}{R^3}} . \tag{62}$$

If the thickness of the boundary layer is $b \ll R_*$ then at the boundary layer the angular velocity is[16],

$$\Omega_K(R_* + b), \tag{63}$$

where R_* is the star's radius. Within the boundary layer the angular velocity is slowed by viscosity. If the angular velocity at the stellar surface is Ω_*, then[16],

$$\Omega_* < \Omega_K(R_*). \tag{64}$$

The boundary layer luminosity is[16],

$$L_{BL} = \frac{GM\dot{M}}{2R_*}\left(1 - \frac{\Omega_*}{\Omega_K}\right)^2 . \tag{65}$$

Equation (65) is inadmissible because Eq. (41) is invalid.

The optically thick boundary layer characteristic blackbody temperature is[16],

$$T_{BL} = \left(\frac{GM\dot{M}}{8\pi H\sigma R_*^2}\right)^{1/4} . \tag{66}$$

The right side of Eq. (66) is not intensive so the equation is false. Using Eq. (45) the boundary layer temperature is given in the alternative form[16],

$$T_{BL} \sim T_*\left(\frac{T_S}{T_*}\right)^{1/8} , \tag{67}$$

where $T_* \equiv T_{disc}$ of invalid Eq. (45) at the stellar radius $R_* \equiv R$ thereof, and the shock temperature is,

$$T_S = \frac{3GM\mu m_H}{8kR_*}, \tag{68}$$

which is analogous to Eq. (31), and therefore, is also invalid. Consequently Eq. (67) is also false.

Astronomers augment what pass for white dwarfs and neutron stars with a magnetic field that channels the accretion flow into the magnetic poles from a magnetospheric boundary layer in an accretion disk. In the case of quasi-spherical accretion far from the star, the radius r_M at which the magnetic energy density is comparable to the kinetic energy density of the accreting material is called the Alfvén radius. In this case the Alfvén radii, in cm, for white dwarfs and neutron stars respectively, are[16],

$$r_M = \begin{Bmatrix} 5.5\times10^8 m_1^{1/7} R_9^{-2/7} L_{33}^{-2/7} \mu_{30}^{4/7} \\ \\ 2.9\times10^8 m_1^{1/7} R_6^{-2/7} L_{37}^{-2/7} \mu_{30}^{4/7} \end{Bmatrix}, \tag{69}$$

where $L_{33} = L_{acc}/10^{33}$ erg s^{-1}, etc., $m_1 = M/M_\Theta$, $\mu = B_* R_*^3$ is a constant, while B_* and R_* represent the magnetic field strength at the stellar surface and the radius of the star respectively. The accretion luminosity L_{acc} is given by Eq. (20), which is invalid. Hence, Eq. (69) is invalid. In the case of accretion disks the annular radius r_d at which the accreting material is deflected into the magnetic poles by the dipole-like magnetic field is[16, 18],

$$r_d = \alpha r_M, \tag{70}$$

where the constant α can take the values ½ ≤ α ≤ 2, depending upon the angle of the magnetic dipole axis to the plane of the accretion disk. Since Eq. (69) is inadmissible so too is Eq. (70).

In the notation used by Carroll and Ostlie[18], the Alfvén radius is denoted by r_A, given by,

$$r_A = \sqrt[7]{\frac{B_S^4 R^{12}}{2GM\dot{M}^2}}, \tag{71}$$

where B_S is the magnetic field strength at the stellar surface and R the stellar radius. Using Eq. (20) this can be written as,

$$r_A = \sqrt[7]{\frac{B_S^4 R^{11}}{2L_{acc}\dot{M}}}. \tag{72}$$

The invalidity of Eq. (20) renders Eqs. (71) and (72) invalid.

The astronomers maintain that X-ray pulsars are accreting neutron stars. To support this claim, they advance that, over time, the accreting neutron star in X-ray binaries spins faster (spin up), so that the pulsation periods decrease. If P is the period then[18],

$$\frac{\dot{P}}{P} = -\frac{P\sqrt{\alpha}}{2\pi I}\left(\frac{B_S^2 R^6 G^3 M^3 \dot{M}^6}{\sqrt{2}}\right)^{1/7}, \tag{73}$$

where $\dot{P} = dP/dt$ and I is the moment of inertia of the star. The numerous adjustable quantities in this expression permit it to be matched to reported measured values to claim consistency with observations. That alone is sufficient to render Eq. (73) unsatisfactory. However, Eq. (73) is invalid. Let J be the angular momentum of the accreting star. Then $J = I\omega$ where I is the moment of inertia and ω the angular velocity. Therefore[18],

$$\frac{dJ}{dt} = I\frac{d\omega}{dt} = I\frac{d}{dt}\left(\frac{2}{P}\right) = -2\pi I\frac{\dot{P}}{P^2}. \tag{74}$$

But[18]

$$\frac{dJ}{dt} = \dot{M}vr_d, \tag{75}$$

where v is the orbital speed at $r = r_d$. Hence[18],

$$v = \sqrt{\frac{GM}{r_d}}. \tag{76}$$

Substituting Eq. (76) into Eq. (75),

$$\frac{dJ}{dt} = \dot{M}r_d\sqrt{\frac{GM}{r_d}}. \tag{77}$$

Equating Eqs. (74) and (77), and using Eqs. (70) and (71), it obtains,

$$\frac{\dot{P}}{P} = -\frac{P\sqrt{\alpha}}{2\pi I}\left(\frac{B_S^2 R^6 G^3 M^3 \dot{M}^6}{\sqrt{2}}\right)^{1/7}, \tag{78}$$

which is just Eq. (73). Since Eqs. (70) and (71) are invalid, Eq. (73) is invalid. Yet from Eq. (73) the astronomers claim "compelling evidence that neutron stars are the accreting objects in binary X-ray pulsars."[18] This claim has no scientific merit.

According to the astronomers, various torques may eventually balance so that the period attains a steady value, until external conditions change which then cause the period to change. The radius, R_Ω, at which a particle attached to a magnetic field line rotates at the Keplerian rate, the astronomers call the 'corotation radius', given by[16],

$$R_\Omega = \sqrt[3]{\frac{GMP_{spin}^2}{4\pi^2}}. \tag{79}$$

The equilibrium spin period occurs when $R_\Omega \sim r_d$. Substituting $R_\Omega \sim r_d$ into Eq. (70) with α = ½ and using Eq. (69) to then solve for the equilibrium spin period in seconds gives[16],

$$P_{eq} \sim \begin{Bmatrix} 3m_1^{-2/7} R_9^{-3/7} L_{33}^{-3/7} \mu_{30}^{6/7} \\ \\ 3m_1^{-2/7} R_6^{-3/7} L_{37}^3 \mu_{30}^{6/7} \end{Bmatrix}. \tag{80}$$

Since Eq. (69) is invalid, Eq. (80) is also invalid.

In the case of disk irradiation by a neutron star the disk temperature is claimed to be[27],

$$T_{disk}(r) = \left[T_{eff}^4(r) + T_{irr}^4(r)\right]^{1/4}, \tag{81}$$

where T_{irr} is "[t]he radiation temperature at the surface of the disk irradiated by a central source"[27], given by,

$$T_{irr} = \left[\frac{\eta \dot{M} c^2 (1-\beta)}{4\pi\sigma r^2} \frac{h}{r}(n-1)\right]^{1/4}, \tag{82}$$

where η is the efficiency of rest mass conversion into energy, β is the X-ray albedo, h is the disk half thickness at radius r, and n is defined by $h \propto r^n$. The disk annular radius is a homogenous function of degree ½. T_{irr} cannot be negative and cannot be zero; therefore $n > 1$. The thermodynamic character of the right side of Eq. (82) is governed by $\dot{M}h / r^3$, or $\dot{M}r^n / r^3$, since $h \propto r^n$. The a homogenous function of degree of the right side then has the form $(1 + n/2 - 3/2)^{1/4}$. But the left side is always a homogenous function of degree 0; therefore $0 = (1 + n/2 - 3/2)^{1/4}$. Consequently, n = 1 and Eq. (82) can never be thermodynamically balanced. Equation (82) is therefore invalid. Although Eq. (81) is prima facie intensive on both sides, simply because it is written with just temperatures on both sides, it is invalid not only because Eq. (82) is invalid but also because temperature, according to the 0th law of thermodynamics, is not additive, because it is intensive, whereas Eq. (81) adds temperatures.

In consequence of the forgoing, the theory of magnetically channelled accretion onto white dwarfs and neutron stars is fallacious, thereby invalidating the theory of AM Herculis stars and DQ Herculis stars (the so-called 'polars' and 'intermediate polars' respectively), along with the theory of binary X-ray pulsars, according to which the they rotate with periods ranging from 0.069 s to 835 s[18], and binary pulsars with millisecond periods, such as PSR 1937+214 which allegedly rotates 642 times per second[18]. Such rotation speeds simply do not exist. It follows that the mechanism advanced for cataclysmic variables is also invalid.

VI. CATACLYSMIC VARIABLES

According to the astronomers where the primary star is a white dwarf, cataclysmic variables and supernova may be produced. The radius of the "expanding model photosphere"[18] of the cataclysmic variable (classical nova) approaches the constant value R_∞ [18],

$$R_\infty = \frac{3\bar{\kappa}\dot{M}_{eject}}{8\pi v}, \tag{83}$$

where $\bar{\kappa}$ is the mean opacity, $\dot{M}_{eject}$ is the rate at which mass is ejected, and v is the constant speed of ejection. The fireball expansion is assumed to eject material as "an optically thick 'fireball' that radiates as a hot black body."[18] The Stefan-Boltzmann law is,

$$L = \varepsilon\sigma AT^4, \tag{84}$$

where ε is the emissivity. In the case of a blackbody $\varepsilon = 1$, so

$$L = \sigma AT^4. \tag{85}$$

Substituting Eq. (83) into Eq. (85) for a spherical fireball, where $A = 4\pi R^2$, the astronomers solve for temperature[18],

$$T_\infty = \left(\frac{L}{4\pi\sigma}\right)^{1/4}\left(\frac{8\pi v}{3\bar{\kappa}\dot{M}_{eject}}\right)^{1/2}. \tag{86}$$

The left side of Eq. (86) is intensive (a homogenous function of degree 0) but the right side is not intensive (being a homogenous function of degree -⅓), so it is invalid.

VII. GALAXY FORMATION AND EVOLUTION

It is noteworthy that violations of the kinetic theory of gases and the laws of thermodynamics in astronomy and astrophysics are not limited to stellar theory; galactic theory is similarly afflicted. For example, in relation to early evolution of elliptical galaxies and the spheroids of disk galaxies, it is claimed that the condition for the stars and gas of a protogalactic cloud "to fall together is $T_0 << T_{vir}$",[28] where T_0 is the central temperature of the cloud and T_{vir} is its 'virial temperature', i.e., "the mean temperature at which the cloud would satisfy the virial theorem"[28], given respectively by,

$$T_0 << \frac{1}{k_B}\frac{GM\mu m_p}{r_h}, \tag{87}$$

and

$$T_{vir} \cong \frac{0.13}{k_B}\frac{GM\mu m_p}{r_h}. \tag{88}$$

In these equations k_B is Boltzmann's constant, μ is the mean molecular weight of the gas, m_p is the proton mass and r_h the median radius of the cloud. Equations (87) and (88) stand in violation of the kinetic theory of gases and the laws of thermodynamics. In the latter case, it is clearly evident that the left side of these equations is a homogenous function of degree 0, but the right side of each is homogeneous of degree ⅔. In the former case, the viral theorem is first invoked for a system of stars[28],

$$2K + W = 0, \tag{89}$$

were K is the kinetic energy of a stellar system with mass M and W the gravitational potential energy. The kinetic energy is given by[28],

$$K = \frac{1}{2} M \langle v^2 \rangle, \tag{90}$$

where $\langle v^2 \rangle$ "is the mean-square speed of the system's stars"[28]. Putting equation (90) into Eq. (89) gives,

$$\langle v^2 \rangle = \frac{|W|}{M} = \frac{GM}{r_g}, \tag{91}$$

where r_g is the 'gravitational radius', defined by[28],

$$r_g = \frac{GM^2}{|W|}. \tag{92}$$

The median radius r_h is said to be related to the gravitational radius by, $r_h \cong 0.4 r_g$ [28]. Equation (91) then becomes,

$$\langle v^2 \rangle = \frac{|W|}{M} \cong 0.4 \frac{GM}{r_h}. \tag{93}$$

The ideal gas law is then invoked for the mean-square speed[28],

$$\langle v^2 \rangle = \frac{3k_B T}{\mu m_p}. \tag{94}$$

Putting $\langle v^2 \rangle$ from Eq. (94) into Eq. (93) gives,

$$T_{vir} \cong \frac{0.13}{k_B} \frac{GM\mu m_p}{r_h}, \tag{95}$$

which is Eq. (88). Since there are no gravitational forces between the particles of an ideal gas, it is a violation of kinetic theory to use the mean-square speed of an ideal gas in Eq. (93); and the motion of the gravitationally collapsing system of stars does not in any way mimic the omnidirectional constant linear motion of ideal gas particles, which collide elastically with one another and the walls of their container. Furthermore, Eq. (95) assigns a temperature to gravitational potential energy when in fact potential energy, gravitational or otherwise, has no temperature and cannot contribute to temperature.

Consequently. Eqs. (87) and (88), and the condition $T_0 << T_{vir}$ for galaxy formation, have no scientific validity whatsoever.

It follows that the theory of galactic heating by supernovae is also false. The minimum "supernova rate that could have heated the gas to T_{vir}"[28] is,

$$\alpha_{\min} = \frac{\Lambda(T_{vir})n_e}{m_p E_{SN}}\left(\frac{\rho_g}{\rho_*}\right) \tag{96}$$

where E_{SN} is the energy pumped by each supernova into the gas, n_e is the electron density, ρ_g is the density of the gas, ρ_* is the density of stars, m_p is the proton mass, and $\Lambda(T_{vir})$ is the cooling function. Since T_{vir} is invalid, $\Lambda(T_{vir})$ is invalid so that Eq. (96) is also invalid.

Another example arises in relation to X-ray halos of elliptical galaxies. According to Binney and Tremaine[28],

> "[T]he gas in the central regions will steadily cool and flow in to the center of the galaxy, where it presumably forms stars. However, the flow velocity is usually much less than the speed of sound, so that approximate hydrostatic equilibrium is maintained in the gas."

Owing to hydrostatic equilibrium, for spherical symmetry[28],

$$\frac{dp}{dr} = -\frac{GM(r)\rho}{r^2}. \tag{97}$$

Here ρ is the gas density, p the gas pressure and $M(r)$ denotes the mass contained within radius r. The ideal gas law can be written,

$$p = \frac{\rho k_B T}{m}, \tag{98}$$

where m is the molecular mass. Using Eq. (98), Eq. (97) can be written as[28],

$$M(r) = \frac{k_B Tr}{G\mu m_p}\left[-\frac{d\ln\rho}{d\ln r} - \frac{d\ln T}{d\ln r}\right]. \tag{99}$$

Equation (99) is invalid. First, combining Eq. (98) with Eq. (97) incorporates gravity into the ideal gas law, thereby violating the ideal gas law because there are no gravitational forces between the particles of an ideal gas. Secondly, Eq. (99) can be expressed as,

$$T = \frac{GM(r)\mu m_p}{r} \frac{1}{k_B\left[-\frac{d\ln\rho}{d\ln r} - \frac{d\ln T}{d\ln r}\right]}, \tag{100}$$

which assigns a temperature to gravitational potential energy. Yet, potential energy has no temperature and cannot contribute to temperature of anything, let alone to the temperature of an ideal gas.

VIII. ACCRETION AND THE STEFAN-BOLTZMANN LAW

The total energy E of an orbiting body of gas of mass m is said to be[18],

$$E = -G\frac{Mm}{2r}. \tag{101}$$

In the case of a ring element of an accretion disk, "the energy dE radiated by the ring in time t"[18] is "equal to the difference in the energy that passes through the ring's outer and inner boundaries"[18] so,

$$dE = \frac{dE}{dr}dr = \frac{d}{dr}\left(-G\frac{Mm}{2r}\right)dr = G\frac{Mm}{2r^2}dr. \tag{102}$$

If the constant mass transfer rate is $\dot{M}$ then $m = \dot{M}t$, so[18],

$$dE = G\frac{M\dot{M}t}{2r^2}dr. \tag{103}$$

In terms of the luminosity dL_{ring} of the outer ring of the disk[18],

$$dL_{ring}t = dE = G\frac{M\dot{M}t}{2r^2}dr. \tag{104}$$

The top and bottom of the outer ring of the disk each have elemental area $A = 2\pi r dr$. The total area is therefore $2A = 4\pi r dr$. Setting $\varepsilon = 1$ in the Stefan-Boltzmann law, Eq. (104) becomes[18],

$$dL_{ring} = 4\pi r\sigma T^4 dr = G\frac{M\dot{M}}{2r^2}dr. \tag{105}$$

Integrating the middle and far right side together yields the invalid Eq. (43) above, for temperature. Now, from Eq. (105),

$$4\pi\sigma T^4 = G\frac{M\dot{M}}{2r}. \tag{106}$$

The annular radius r is a homogenous function of degree ½, mass M and constant mass transfer rate $\dot{M}$ are each a homogenous function of degree 1. The left side is a homogenous function of degree 0 but the right side is a homogenous function of degree 3/2. Thus, Eqs. (104) through to (106) are all invalid. Integration together of the far left side and the far right side of Eq. (105) from $r = R$ to $r \to \infty$ gives[18],

$$L_{disk} = G\frac{M\dot{M}}{2R}. \tag{107}$$

In the absence of an accretion disk, the accretion rate onto the primary star is twice as great (see Eq. (41) above), so that[18],

$$L_{acc} = G\frac{M\dot{M}}{R}, \tag{108}$$

which is just Eq. (22) above. Owing to the invalidity of Eq. (104), Eq. (22) is false; and so too Eq. (41) and Eq. (107).

It has already been noted above, in relation to Eqs. (59), (60) and (61), that variations in luminosity are due to differing areas and emissivities, in accordance with the Stefan-Boltzmann law. It is a laboratory established fact that gases do not emit thermal spectra. A blackbody spectrum is a thermal spectrum but not all thermal spectra are blackbody because thermal spectra vary with emissivity[24]. The emissivity of a material is independent of the mass or surface area of the material. It is also a laboratory established fact that only condensed matter emits thermal spectra. This is because a thermal spectrum is only produced by a vibrational lattice, present in condensed matter, but which gases do not possess[24]. The Stefan-Boltzmann law contains emissivity,

$$L = \varepsilon\sigma A T^4. \tag{109}$$

An emissivity cannot be assigned to a gas. Emissivity is a characteristic of only condensed matter and varies with the material of the radiating body. The setting of $\varepsilon = 1$ for a blackbody in the Stefan-Boltzmann law is necessarily in relation to condensed matter. The astronomers and astrophysicists incorrectly assign blackbody spectra to gases using Eq. (109), in violation of the Stefan-Boltzmann law. Eddington's invalid mass-luminosity relation has the very same faulty ætiology.[21] Consequently all luminosities expressed in terms of gaseous masses are false.

IX. CONCLUSION

The theory of stellar accretion is false due to profound violations of the kinetic theory of gases and the laws of thermodynamics. Temperature is always intensive and mass is always extensive in any proposed thermodynamic mathematical relation, yet the theory of stellar accretion is replete with nonintensive temperatures and nonextensive masses, with additional thermodynamically unbalanced luminosities. Contrary to the consensus contention, X-ray pulsars are not "powered by the gravitational potential energy released by accreting matter"[18].

Disk accretion has been implicated in the early evolution of fully convective, low mass pre-main sequence stars and the assignment of age "to the youngest objects".[29] Owing to the falsity of the theory of accretion the standard theory of stellar evolution is invalidated.

The invalidity of the standard model theory of nuclear reactions in stars,[30] the invalidity of the theory of white dwarfs and other ultra-dense compact stars,[31] coupled with the invalidity of the theory of stellar accretion, the theory of gaseous stars has no scientific basis.

The current theory of galaxy formation and evolution is false for the very same violations of kinetic theory and thermodynamics.

Astronomy and astrophysics are compelled into a paradigm shift of profound importance with the recognition that the stars are comprised of condensed matter and therefore essentially incompressible[23], the upshot being that stars do not self-compress to form white dwarfs, neutron stars and black holes. What currently classify for white dwarfs and neutron stars are not ultra-dense compact stellar bodies. Stars are not comprised of degenerate electron gases or neutrons. Stars with the mass of the Sun and the size of Earth, gaseous stars with a density 2,000 times that of platinum[19], neutron stars and black holes, do not exist; they are the products of ill-conceived theories.

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