

New Thermodynamics: Temperature, Sun's Insolation, Thermal, and Blackbody Radiation

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Abstract—The various relationships between the temperature's witnessed here on Earth, the Sun's isolation, thermal energy and blackbody radiation are all poorly understood. Herein, the interrelations are examined, and a new theory concerning their relationships is presented. This also puts limitations upon temperature being related to a system's thermal energy density. It also gives new insights into why inferences based upon infrared spectrometry, do not match those associated with heat capacities. Furthermore, new understandings concerning the inelastic nature of both intermolecular and intramolecular collisions will be proposed. This all will have profound implications to our understanding of thermodynamics, such as what is blackbody radiation, thermal radiation, and temperature, cumulating in profound implications concerning how we view global warming.

Index Terms—New Thermodynamics, Blackbody Radiation, Global Warming, Temperature, Sun's Insolation.

I. INTRODUCTION

Traditionally in thermodynamics the notion of thermal energy lacks the precision of clarity. One considers temperature (T) as the parameter that relates to the kinematic motions at the molecular level in most matter. This actually forms the basis of statistical thermodynamics, as can be found in most contemporary books [1,2]. Statistical arguments are based upon the kinematics of matter, hence the bizarre notion that all vacuums have no temperature, has become accepted.

When measuring a system's temperature, a thermometer is placed into thermal contact with that system. Thermal equilibrium occurs once the influx of thermal energy equals the efflux between both the thermometer, and the system. This actually forms the basis of the transitive property known as the zeroth law of thermodynamics which states that "If two systems are in thermal equilibrium with a third system, they must be in thermal equilibrium with each other" [1, pg 282]. Intuitively, the third system may be considered a thermometer.

The following metaphysical argument arises. Traditionalists claim that the act of placing a thermometer into the vacuum, is the act of giving that vacuum a temperature. Certainly, the energy associated with thermal radiation is generally minute, when compared to the thermal energy of molecular motions. Therefore, more often than not, ignoring a system's thermal radiation, enables one to still accurately calculate a system's total thermal energy. This does not mean that a vacuum has no temperature.

When a spectrum of photons strikes matter, the photons are either, (a) reflected by the matter's surface, where

reflected visible spectrum photons give the matter its color, (b) transmitted through the matter, i.e., do not interact with the matter except for the photon's refraction, or (c) absorbed into the matter becoming molecular vibrations within that matter, i.e., thermal phonons.

A blackbody is considered to be the perfect absorber, which is to say that all incident radiation is absorbed by the matter thus explaining its blackness, e.g., carbon black is considered as the perfect absorber, i.e., its absorptivity approaches unity. A perfect absorber by definition is also a perfect emitter, and this is Stewart's Law [3], i.e., a perfect emitter's emissivity also approaches unity. A graybody is a substance whose emissivity is less than unity.

II. INTRODUCTION: BLACKBODY RADIATION

The Stefan-Boltzmann law states that the total emitted power (P) is proportional to the matter's temperature to the fourth power, which is generally considered as being blackbody radiation [3]:

$$P = A\varepsilon\sigma T^4 \quad (1)$$

where ε = emissivity $\sigma = 2\pi^5k^4/15c^2h^3 = 5.670400 \times 10^{-8}$ J/sm²k⁴, and A = surface area [4]

The spectral radiancy gives the power emitted [$P_{B(\nu)}$] at each frequency (ν), [4]. Confusingly, the radiance (W/sr·m²) (aka intensity) of a substance is the radiant flux emitted or received, by a surface in a given direction per unit solid angle per unit area. Irradiance is the power received per unit surface area with units being W/m². And The spectral irradiance is the irradiance per unit wavelength or frequency.

Realizing that radiancy must be proportional to the energy density, then one can write [4].

$$\rho_B = aT^4 \quad (2)$$

where ρ_B is the power associated with the blackbody energy density, and a is the blackbody radiation constant $a = 8\pi^5k^4/15c^3h^3$.

Based upon 19th century experiments with blackened (lamp black) cavities, it is now accepted that any such cavity will be filled with blackbody radiation and that, if a hole was put into the blackened enclosure, any emitted light coming out of that enclosure would be blackbody in nature. Accordingly, the concept of blackbody radiation became associated with above absolute zero enclosures.

The acceptance of traditional blackbody assertions is not universal, e.g., Robitaille [3] has claimed that the sciences wrongly chosen to adhere to Kirchoff's theory over that of Balfour Stewart.

It should also be noted that the classic idea of a blackbody in equilibrium emitting radiation at all frequencies did lead to what is commonly referred to as the UV catastrophe. This was avoided by Planck's realization that electromagnetic radiation is quantized, i.e., that being the photon. Leaving the details to others, this has also led to the concept that blackbody radiation can only be mathematically related to crystalline condensed matter [3].

III. INTRODUCTION: EMISSIVITY VS ABSORPTIVITY

An object with no internal heat source is in thermal equilibrium with its surroundings, when that object emits as much radiation energy as it absorbs. Consider a thermometer placed in a vacuum filled with blackbody radiation. When in thermal equilibrium, based upon (2) the measured temperature is:

$$T = (\rho_B/a)^{1/4} \quad (3)$$

Again, ask did the vacuum have a temperature prior to the placement of the thermometer into it? Based upon (3), I would argue that it had a temperature. Of course, this assumes that the vacuum is sufficiently immense that its total thermal radiation is significantly greater than the total thermal energy that was contained within the thermometer, prior to its placement. As previously stated, the above contravenes traditional assertions?

IV. INTRODUCTION: TEMPERATURE VS THERMAL ENERGY

It is accepted that when, $hc/\lambda = h\nu \ll kT$, the energy density, as defined by(2) can be obtained using the Rayleigh-Jeans approximation:

$$\rho_B = a'T \quad (4)$$

where ρ_B is the radiation's energy density, and a' is the Rayleigh-Jeans constant, which differs from the constant " a " in (2). In SI units, the units for a' are, J/K.m³.

Here on Earth, a system's energy change often is proportional to its temperature change. For example, an isometric system's total energy change (dE_T) can be determined in terms of its isometric heat capacity (C_V), and its temperature change (dT) by:

$$dE_T = C_V dT \quad (5)$$

Note that, if the system's energy change is solely due to the isometric input of thermal energy [$dQ_{in(v)}$], then $dE_T=dQ_{in}$, and then (5) becomes:

$$dQ_{in(v)} = C_V dT \quad (6)$$

Also, if the isometric heat capacity is per gram (c_v), then (5) or (6) can be readily rewritten in terms of the system's mass by understanding that, $C_V=mc_v$.

For an isobaric expanding system, in terms of its isobaric heat capacity (C_P), and its temperature change (dT), the isobaric thermal energy input [$dQ_{in(p)}$] becomes:

$$dQ_{in(p)} = C_P dT \quad (7)$$

Unlike the isometric system, the isobaric expanding system performs lost work (W_{lost}) onto the surrounding atmosphere, as defined by [5,6,7,8,9]:

$$W_{lost} = (PdV)_{atm} \quad (8)$$

Of course, the thermal energy required for the expanding isobaric system [$dQ_{in(ip)}$] can be rewritten in terms of lost work, isometric heat capacity (C_V), and the system's temperature change, as follows:

$$dQ_{in(p)} = C_V dT + (PdV)_{atm} \quad (9)$$

And in terms of the expanding system's energy change, (9) becomes:

$$dQ_{in(p)} = dE_T + (PdV)_{atm} \quad (10)$$

Equation (10) assumes that the system does no other work except for the lost work into the atmosphere [9]. Understandably, the difference between isometric heating, and isobaric heating of a system, lay in the fact that isobaric heating involves lost work, while the isometric heating involves no work. Therefore, for two system's experiencing the same temperature change (dT), the difference between isometric (C_V) and isobaric (C_P) heat capacities is the lost work, i.e. [6,8]:

$$C_P dT = C_V dT + (PdV)_{atm} \quad (11)$$

Collecting the terms:

$$C_P - C_V = (PdV)_{atm}/dT \quad (12)$$

Realizing that for a mole of ideal gas, $\frac{PdV}{dT} = R$, then (12) can be rewritten in terms of molar heat capacities in the following traditionally accepted form:

$$C_P - C_V = R \quad (13)$$

Based upon equations (5), (6) and (7), it becomes obvious that changes to most system's energy is directly proportional to that system's temperature change (dT). Of interest, the differences in isobaric and isometric heat capacities is also related to temperature change, i.e., (12). Can this all be explained in terms of radiation, whether it be thermal or blackbody? And then, be related to (4)?

V. WHAT IS THERMAL ENERGY?

Thermal energy resides within condensed matter, as both intermolecular vibrations that are between molecules, and intramolecular vibrations that are between the various atoms within a molecule. A better definition may be that thermal energy consists of a spectrum of thermal photons (thermal radiation) whose wavelengths are sufficiently long that they are readily absorbed by condensed matter plus any phonons that are associated with molecular vibrations (both inter and

intra). Of course, a most rudimentary definition being that thermal energy is heat.

Here on Earth, thermal energy primarily involves frequencies at, and/or close to the infrared spectrum with the emphasis on the “thermal infrared” [aka mid infrared: ($3\mu\text{m} < \lambda < 8\mu\text{m}$)] and into the far infrared [aka long infrared ($8\mu\text{m} < \lambda < 15\mu\text{m}$)].

Shorter wavelength photons, such as those in the near infrared ($740\text{nm} < \lambda < 3\mu\text{m}$) and those considered as visible light ($380\text{nm} < \lambda < 740\text{nm}$) can also contribute as thermal energy, e.g., when they are absorbed by matter. This absorbed energy becomes part of that matter’s various vibrational energies. And this energy is generally, then re-radiated as thermal photons, i.e., at a lower frequency (infrared) than the absorbed frequencies.

VI. WHAT ABOUT BLACKBODY RADIATION?

Blackbody radiation is theoretically limited to cavities within crystalline matter. Strangely, it is also association with radiation from both our Sun, and very hot molten metal, neither of which are crystalline.

Moreover, both liquids and amorphous solids lack any crystalline structure, and yet it is accepted that the thermal energy resides. “Is this not also blackbody?”

Based upon accepted theory one might argue that there is some profound difference between thermal energy and blackbody radiation beyond their associations with temperature. Yet when considering their heat capacities, all condensed matter fundamentally adheres to the same principles, e.g., the law of Dulong and Petit. It strikes this author as odd that crystalline solids thermally behave the same as amorphous solids, yet theoretically they are not theoretically considered the same it comes to their radiation.

One conclusion may be that there is something amiss with the purely mathematically based theory that limits blackbody radiation to crystalline substances. To repeat, “how can the absorption of thermal photons be so similar, yet this energy’s emission is not?” “Does this not contravene Stewarts law?”

“What about gases?” It is accepted by most scholars that homonuclear gases do not adsorb infrared radiation, all because it does not show up in their infrared spectra. This author has previously suggested that this is due to the calibration of spectrometers, that being due to the subtraction of the blank [10]. And this has led to a poorly understood science, e.g., a probably grandiose mistake in our modelling climate change upon greenhouse effect by certain gases [10].

This above subtraction of a blank is the removal of the gas’s blackbody spectrum, as defined by (1). “Could this the subtraction of the spectrometer’s content’s actual thermal signature?” Let us now examine this plausibility in more depth than was previously discussed [10].

VII. PROBLEMATIC INFRARED SPECTROMETRY

In spectrometry the gases are in thermal equilibrium, and therefore the molecules adsorb as much thermal energy, as

they radiate. Therefore, concerning infrared spectrometry, one is left with two choices. Either:

- 1) Polyatomic gases neither adsorb, nor radiate, blackbody/thermal radiation.
- 2) Polyatomic gases do adsorb, and then re-radiate blackbody/thermal radiation.

Number 1) is the accepted traditional assertion. This is in part based upon the mathematical narrative that limits blackbody radiation to cavities within crystalline solids.

Strangely, polyatomic gas’ heat capacity indicate that they all absorb thermal energy, as part of their intramolecular vibrational energy (E_v). And this vibrational energy was shown by this author to be related to the number of atoms in the molecule (n''), its temperature (T) and Boltzmann’s constant (k) by:

$$\bar{E}_v \cong (n'' - 1)kT \quad (14)$$

Equation (14) is based upon an improved kinetic theory that is a superior fit to known heat capacities [11,12].

When measuring a gas’ heat capacity, the gas is not in thermal equilibrium. Are we to believe that “polyatomic gas molecules do not adsorb thermal radiation, i.e., the above vibrational energy is all attained from what, their collisions with wall molecules?” Such an assertion is troublesome, especially when one contemplates all the various shapes, and sizes of gas molecules.

There remains only one viable solution, which explains why most polyatomic gases adhere to (14). That is as follows. All polyatomic gas molecules absorb and, then re-radiate thermal radiation, as part of their vibrational energy. So, the next question becomes, “is this thermal radiation, actually blackbody radiation?”

Answering yes, then one begins to fully understand why there are such strong discrepancies between their heat capacities, and the traditionally accepted infrared spectrums of so many polyatomic gases. For example, it is traditionally thought that homonuclear gases have no absorption spectra in the infrared [10], even though they all clearly absorb thermal energy, as indicated by their heat capacities [11,12].

One must conclude that all polyatomic gases adsorb, and then re-radiate infrared thermal radiation, when in thermal equilibrium with their surroundings, even when inside of a spectrometer. This is part of any polyatomic gas’ vibrational energy, and that this is infrared thermal radiation, as defined by the Stephen-Boltzmann law, i.e., blackbody radiation!

In other words, the above 2) is correct, while traditionally accepted 1) has to be wrong.

The above further means that in traditional infrared spectrometry, what one traditionally has witnessed, are the parts of a gas’ infrared spectrum that are not necessarily directly attributable to the molecule’s normal thermal signature, e.g., its dipole moments.

Can we now conclude that “all thermal energy is blackbody radiation?” No, such a conclusion cannot be had, at this point.

VIII. OUR SUN’S INSOLATION

“Is the near infrared [aka visible infrared: 740 nm to 3000 nm], actually part of what is called thermal radiation?” Interestingly, near infrared emission and adsorption are

often attributed to changes in a molecule's rotational-vibrational movement, which implies some sort of thermal energy. Of course, our new understanding poises the

question "is this in excess of the thermal signature that is generally subtracted as a blank in a spectrometer?" It seems logical.

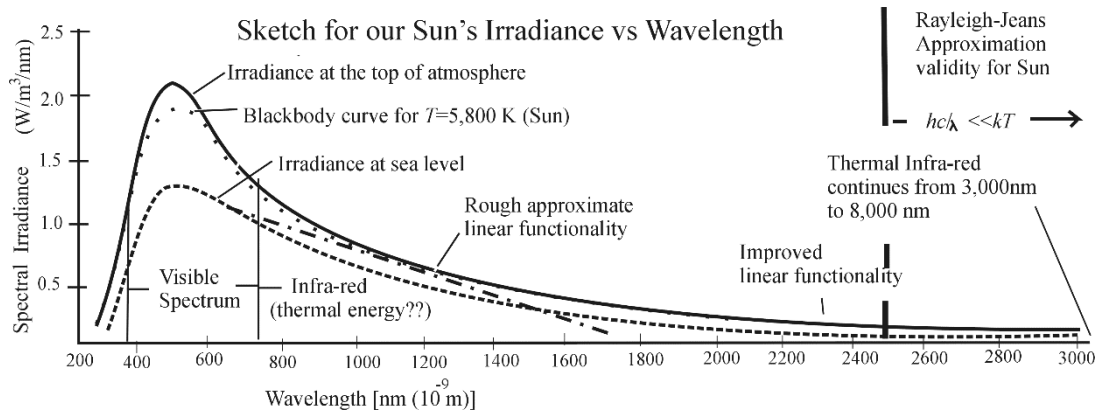


Fig. 1. Sketch illustrating the differences in our Sun's spectral irradiance at the top of the atmosphere versus at sea level. Notice how the curve flattens out as the wavelengths become longer.

Fig. 1 shows our Sun's irradiance versus wavelength, i.e., blackbody curve for $T=5,700$ K. It is accepted that our Solar radiation is; 5% ultraviolet (300-370 nm), 43% visible (370-740 nm), and 52% infrared [13]. Note that, Fig. 1 only shows up to the near infrared (740-3,000 nm), with the thermal infrared starting at 3,000 nm, i.e., extending to the far right.

Consider the near infrared spectral irradiance, as is witnessed at sea level. It roughly approximates a "decreasing linear" function of increasing wavelength. However, the requirement for the Rayleigh-Jeans's approximation as ascribed by $\frac{hc}{\lambda} \ll kT$ is not valid for most of the near infrared. It can be shown that $\frac{hc}{\lambda} \approx kT$ when, $\lambda \approx 2,500$ nm = $2.5\mu\text{m}$. I.e., the Rayleigh-Jeans approximation when applied to our Sun's insolation only becomes valid when $\lambda > 2.5\mu\text{m}$.

Accepting that $\lambda > 3\mu\text{m} = 3,000$ nm constitutes the majority of thermal energy that is witnessed here on Earth, may help explain why system's thermal energies here on Earth tend to be directly proportional to temperature. When viewed in Fig. 1, it visually appears irrelevant.

IX. COMPARING SUN'S INFRARED TO VISIBLE

Consider the energy radiated by our Sun in the near infrared. As illustrated in Fig. 1, the approximate triangle enclosed by the "rough approximate linear functionality" and wavelength, has an approximate area of:

$$(\frac{1}{2})(1.35)(2,000-450) = 1,046 \text{ W/m}^3$$

Fig. 2 illustrates our Sun's spectral irradiance, so that it includes both its thermal infrared (aka mid infrared) and far infrared (aka long infrared), i.e., (3,000 nm to 100,000 nm). As illustrated, for energy associated with the thermal infrared into the far infrared, the area can be approximated by:

$$(0.075)(100,000-3,000) = 7,275 \text{ W/m}^3$$

Based upon the above rough approximation; at sea level the energy associated with both the thermal and far infrared may be several times the energy that is associated with the near infrared and into the visible spectrum. Obviously, the visual appearances of our Sun's insolation, such as Fig. 1, can be deceptive to the eye.

It raises the question as to, "how exactly was the thermal infrared measured?". In the previous calculation, it was assumed to be an asymptote curve, which could be approximated as a linear line parallel to the wavelength. Even if it was considered as a decreasing function, so that we are now considering the area in a triangle, then our Sun's thermal energy would still be 3 or more times greater.

One must also decide as to what all constitutes thermal energy. What if "our Sun's actual thermal radiation started at 2,000 nm that being close to the *improved linear functionality* in Fig. 1, and then extended through the far infrared, as sketched in Fig. 2?" Now our Sun's thermal radiation becomes closer to 8 times that of its visible and near infrared radiation.

Moreover, if our Sun's thermal radiation was considered to start in the near infrared then one might deduce that the Sun's thermal radiation was significantly greater than its radiation associated with visible light. And "what about those frequencies absorbed by matter in the visible spectrum?"

At this point we are not claiming to know all the frequencies that constitute thermal energy, but it may constitute much more of our Sun's insolation than most currently believe.

Microwave ($\lambda > 100,000$ nm) has not been considered. Arguably, some frequencies may be considered as thermal energy, although not necessarily in the same manner as infrared.

Part of the reason that it is so awkward to properly visualize and then interpret may be the constant changing of scale of wavelengths, e.g., nm, μm , mm.

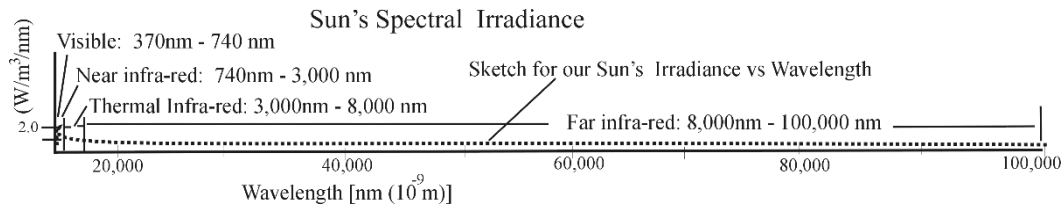


Fig. 2. Sketch for our Sun's spectral irradiance for visible light through to the far infrared

X. TEMPERATURE'S LINEAR FUNCTIONALITY REVISITED

"Does this help explain the assertion that temperature is directly proportional to the thermal energy density here on Earth's surface?" It is certainly getting interesting but it is still not conclusive. Namely, "how does one now explain the reality that system's here on Earth radiate blackbody radiation whose thermal signature cannot be approximated as some linear function of temperature?"

Temperature is a comparative based upon the Zeroth law. Here on Earth, all comparisons are made to our atmosphere, whose temperature is strongly influenced by our Sun's insolation. Arguably, our atmosphere's temperature adheres to the Rayleigh-Jeans approximation.

Furthermore, thermal equilibrium does not mean that two systems in thermal contact exchange precisely the same radiation spectrum. Rather that they exchange the same quantity of thermal energy. And here on Earth, as the biggest of all heat sinks/baths, our atmosphere will govern the relationships that define any exchanges of thermal energy.

So perhaps, the best explanation for thermal energy witnessed here on Earth generally being a linear function of temperature is as follows. "Our atmosphere has its thermal energy density (E_T/V) directly proportional to temperature (T). And since all our systems are ultimately compared to the comparatively massive atmosphere then they too can be contemplated in terms of, $E_T/V \propto T$."

XI. RETHINKING BLACKBODY RADIATION

Instead of thinking of blackbody radiation as the spectrum that is adsorbed and then re-radiated by most forms of matter, "what if we think of it as the radiation associated with inelastic molecular (both inter and intra) collisions?" Just as Bremsstrahlung radiation is associated with an electron's braking in an EM field, blackbody radiation may now be associated with inelastic collisions, at the molecular scale.

Then the hotter the matter ($T \uparrow$) is, the more energetic the molecular (inter and/or intra) collisions will be. Therefore, the greater the frequency of the peak intensity for the collision induced photons would be. Moreover, it would help explain what is witnessed, whether one is considering the blackbody radiation from either condensed matter, or from a polyatomic gas, i.e., the witnessed radiation is due to molecular collisions, and this creates a blackbody spectrum.

Certainly, it would explain why one witnesses blackbody radiation in an enclosure, whether that enclosure is a vacuum, or is filled with a gas. Equally, it should help provide a correlation between P - T relationships and the sun's insolation. In so far as this would explain so much, at this point, it still must be taken as speculation.

Another question arises, "to what degree is the measured solar radiance at sea level actually due to our Sun's solar influx, versus being a result of heat created during the numerous atmospheric intermolecular inelastic collisions [10,14], e.g., P - T relation [10,15]?" It should be some combination of both. And if they are all related by similar Stephen-Boltzmann relationships (blackbody radiations) then thermal equilibrium may mean that we may never be able to separate them, when taking a measurement.

XII. TEMPERATURE'S LIMITS

As shown in Fig. 3, at the temperatures of hot blast furnaces ($T=1,800$ K) the peak radiation is in the near infrared. At such high temperatures, the thermal energy density is best defined by (2), e.g., it is not a linear function of temperature. Moreover, at such high temperatures the energy density associated with the blast furnace will be significantly greater than that of the surrounding atmosphere, hence the blast furnaces thermal energy will dominate what is witnessed. Therefore, a blast furnace is a system whose interaction with other system's cannot be expressed in terms of a linear function of temperature. This explains the white-hot blackbody radiation witnessed from hot molten metal, even though the visible part of the spectrum remains rather small for blackbody spectrum for $T=1,800$ K.

At room temperature ($T=300$ K), the thermal infrared into the far infrared dominates the blackbody spectrum. Arguably at such temperatures the energy associated with the surrounding atmosphere will dominate what is witnessed.

Therefore, a system at 300 K radiates thermal centered blackbody energy, which disperses into the atmosphere, whose thermal radiation energy is clearly a linear function of temperature.

Similarly, the kinematic energies of the atmospheric gases are influenced by their absorption of the surrounding atmosphere's thermal radiation. This occurs even though they are not necessarily in a fully enclosed system, as is used to calculate their heat capacities and their relations to kinetic theory. This applies whether it be the traditional, or the more exacting kinetic theory developed by this author [11,12].

Interestingly, at $T=3$ K, the blackbody radiation is dominated by microwave radiation, which is not exactly what one considers, as being true/pure thermal energy. It becomes increasingly obvious that as $T \rightarrow 0$, any clear relationship between temperature and thermal energy density will be lost.

Of interest, the traditional assertion is that the heat capacities are not constant for all temperature regimes, e.g., heat capacity falters as $T \rightarrow 0$. One can now consider that it is not the notion of heat capacity that falters, rather it is our concept of temperature that collapses. Of course, this raises the question of, "when is a system's temperature no longer

directly proportional to its thermal energy density?" At this time, the answer is really a guess, 10 K, 100 K, 250 K.

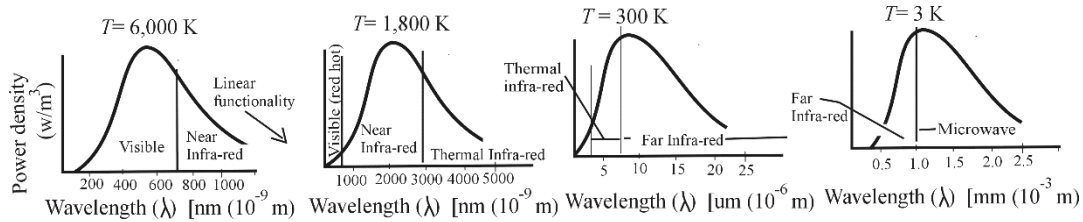


Fig. 3. The blackbody radiation power density versus wavelengths for $T=6,000$ (Sun), $1,800$ K, $T=300$ K (room temperature), and 3 K [(cosmic background radiation (CBR))]. The relationship between blackbody radiation and what is considered as thermal energy obviously changes with different temperatures

Clearly, the relationships between the thermal energy density, and blackbody radiation is not the same for all temperature regimes.

XIII. IMPLICATIONS TO GLOBAL WARMING

This author has previously challenged traditional assertions concerning climate change [10]. “Does what was discussed herein change our modelling for global warming?”

Consider that our Sun’s insolation is better depicted by Fig. 2, than Fig. 1. Therefore, the Sun’s insolation is actually dominated by thermal photons, that being at infra-red frequencies. Such thermal photons are readily adsorbed and then radially re-radiated by most all of our atmospheric gases, including the so-called greenhouse gases.

Then would not our atmosphere reflect significant quantities of our Sun’s earthbound thermal radiation back out into space. Just as it reflects much of Earth’s outer space bound infrared thermal radiation back towards the earth’s surface? This would be similar to how ozone in the upper atmosphere protects us from UV radiation.

It raises the question as to “do the greenhouse gases in the upper atmosphere actually heat or cool our planet?” It would certainly help explain why Earth’s thermosphere is so hot.

If true, then this adds credence to the idea that it is man’s actual activities that are to blame for global warming rather than the so-called greenhouse effect [10]. By man’s activities I mean the heat created/generated by our actual activities i.e., the powering of, and movements of such things like cars, planes, trains etc.

It must be understood that the consideration of this rewriting of the science should be a priority, especially in light of the fact that this changes our understanding of climate change, that arguably being the biggest issue facing mankind.

I recently saw a show on public TV titled, “Climate change by the numbers” (by BBC). They discussed that based upon statistics that there is over a 95% chance that Earth’s recent warming is due to man’s activities. Of course, they then wrongly assumed that the accepted green-house effect science was correct. The mistake is founded in the infrared spectrometry mistake discussed in this paper, and my other paper [10], i.e., mistake being the subtraction of blanks during calibration in infrared spectrometry.

It becomes rather obvious that a gas’s ability to absorb thermal energy should be based upon their heat capacities and not their infrared spectrums. At least not on the infrared spectrums in their current forms.

XIV. NEW THERMODYNAMICS

This author previously discussed the concept behind his new thermodynamics in this journal [9]. Concerning global warming I would emphasize, “Never forget: Intermolecular collisions are inelastic, therefore most all forced changes to our atmosphere’s natural state will result in its heating.” This means that the movements of electric cars will also heat our planet, probably not quite to the same degree as the internal combustion engine, but the true answer will lay in how the electricity is generated.

Our reality remains climate change is due to Man’s activities, and this must be addressed.

XV. CONCLUSION

The interactions between blackbody/thermal radiation, and matter is not as well understood, was previously thought.

It has clearly been argued that blackbody/thermal phonons/photons are adsorbed/radiated by all forms of matter, whether it be solid (both crystalline and amorphous), liquid, or even a polyatomic gas. The theoretical mistakes have been re-enforced by the subtraction of blanks in infrared spectrometry.

Heat capacities clearly demonstrate that gases, liquids and solids (both amorphous and crystalline) all can, and will adsorb/radiate their surrounding thermal/blackbody radiation, most often in rather similar manners.

Thermal energy, was considered as the energy that causes molecular vibrations (both inter and intra). This then raises the question as to “is thermal energy a form of blackbody radiation?” The answer is probably that not all thermal energy is necessarily blackbody.

Although, thermal energy is not always blackbody, molecular vibrations will result in blackbody radiation. It has been hypothesized that this is all due to their inelastic molecular collisions (both inter and intra), i.e., blackbody radiation is the spectrum that is a result of inelastic molecular collisions. This would explain temperature functionality of blackbody radiation, i.e., higher temperature, the greater the impacts between molecules, and hence the greater the mean frequency of the resultant radiation due to these inelastic collisions.

It should be reemphasized that thermal equilibrium does not mean that matter emits the exact same spectrum that it absorbs, rather thermal equilibrium means that the flux/rate of thermal energy emitted equals the rate of energy absorbed, for any system without an internal heat source.

As was previously discussed, the energy of thermal/blackbody radiation tends to be insignificant when compared to the energy associated with the kinematics of matter for most systems. So much so, that the energy associated with the radiation often can be approximated as being zero, when calculating a system's total thermal energy.

However, due to the speed of the light, over time a significant quantity of energy can be exchanged by thermal/blackbody radiation, even though its instantaneous total energy remains comparatively small.

Importantly, the thermal radiation existing in freespace is relevant to a proper understanding of thermodynamics. It is probably the case that the thermal energy from our Sun's insolation can be approximated by some linear function of temperature. Hence, our Sun's radiance may help us understand temperature's linear functionality, as witness here on Earth, with our atmosphere being the massive heat sink/bath to which most other systems are compared.

Clarity as to the exact meaning concerning thermal energy remains awkward. Accepting that it is the energy that results in molecular vibrations, then it is primarily in the thermal infrared and extends into the far infrared spectrum. Depending upon the matter in question, and it may also include certain frequencies in both the visible, and near infrared, as well as the microwave.

Here on Earth's surface, we may reside in a unique position where a system's thermal energy density is linearly proportional to its temperature. Moreover, this linear functionality has a temperature range, i.e., it does not apply to either high temperature systems, e.g. blast furnaces, nor to low temperature systems, e.g. systems approaching absolute zero. The exactness of such limitations, have yet to be properly determined.

The implication of the new understandings presented herein will be fundamental in any new understanding of thermodynamics. It also means that there exists a need to create new realistic models for climate change, models that recognize that global warming is due to man's activities and have little to do with the so-called greenhouse gases.

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