The Collapse of the Big Bang and the Gaseous Sun

If I choose this avenue, it is because I am at a loss in dealing with the scientific publication of this material. The ideas are both too simple and unexpected to stand any chance of publication in the peer reviewed physics literature.

1. The Temperature of the Universe and The Big Bang: (see www.thermalphysics.org)

Kirchhoff's Law of Thermal (or Blackbody) Emission[1] deals with the transfer of heat through space. Formulated in 1859, Kirchhoff's Law[1] is central to modern astrophysics since it enables the study of the temperature of objects through the analysis of the photons (or light) they emit. It is through the analysis of such photons that scientists believe that "the temperature of the universe" has been measured.[2,3] The COBE satellite[4] has now set this temperature with great precision to 2.728±0.004 K (-455° Fahrenheit). The "temperature of the universe" is viewed as the central proof of the Big Bang.

In the mid-1800's, scientists produced blackbodies by covering objects with black paint. Since the paint was black, the body became a nearly perfect absorber/emitter of radiation. Alternatively, blackbodies were produced from an enclosed cavity with a small hole enabling light to enter or exit. In either case, these blackbodies were limited to solids. Kirchhoff utilized mathematics to extend his findings making his law universal to all bodies. Through the formulation of Kirchhoff's Law, many believe that the conclusions Kirchhoff reached relative to Blackbody Radiation could be extended to all phases of matter. However, to be properly applied, Kirchhoff's Law requires that the body in question be in equilibrium with an adiabatic enclosure. It is impossible for anything other than a solid to approach meeting this requirement. Pure liquids, gases and plasmas can never enclose themselves in a near equilibrium manner. Therefore, they can never be considered blackbodies. No pure gas or plasma has ever produced a "blackbody spectrum" as Kirchhoff observed for solids in the laboratory. In fact, because of their fundamental nature, gases and plasmas are unable to emit radiation in this manner without being enclosed. Gases and plasmas, by themselves, lack the internal lattice structure required to support the necessary atomic vibrations. As a result, gases typically absorb or emit radiation in numerous narrow bands often reflecting their quantized vibrational and rotational states. As for liquids, little is known about the nature of their thermal emissions.

As such, the universality of Blackbody Radiation has been overstated. It is imprudent to speak in terms of "blackbodies" without noting, as Kirchhoff did, the constraints of the enclosure. The underlying physical cause of thermal radiation must not be ignored and this includes the internal structure of matter. Yet Einstein's[5] derivation of Planck's Law,[6] though masterful, has lead some to ignore Kirchoff, thermal equilibrium and the physical realities of involved in thermal emission.

While the signal measured by the COBE satellite[4] is indeed thermal in origin,[3] it does not correspond to a real temperature. Moreover, it will eventually be discovered that the signal of the COBE satellite[4] is not associated with the "temperature of the universe," but is produced by the oceans. This accounts for the fantastic signal to noise obtained in the COBE measurements. The detector is in close proximity to the source (i.e. – the earth). The oceans fail to meet Kirchhoff's requirement for equilibrium with an adiabatic enclosure. As such, they produce a thermal curve reporting an incorrect temperature. This is a manifestation that the oceans are liquids and that they, unlike solids, possess translational and rotational degrees of freedom. This is seen in their enormous convection currents. Translational and rotational degrees of freedom can act as energy "sinks" lowering the amount of energy available to the vibrational degrees of freedom available for thermal emission. Extensive Mie scattering causes the COBE signal to be nearly isotropic even when viewed near the earth. Since the COBE signal will no longer be associated with the remnants of the Big Bang, and since the "temperature of the universe" has been hailed as the proof of the Big Bang, this theory cannot easily be sustained. It is impossible to measure a "temperature of the universe" for the simple reason that the requirements set down by Kirchhoff can never be met in a Big Bang scenario. The "primordial mass" was never in equilibrium with an adiabatic enclosure. We will never know the temperature of the universe.

2. The Current Gaseous Model of the Sun:

In 1870, Lane published his discussion of the gaseous nature of the sun.[7] At the time, of course, one could have had little idea about whether or not the sun was really a gas. Nonetheless, Eddington[8,9] would build on the ideas of Lane.[7] Eddington believed that the laws of physics and thermodynamics could be used to deduce the internal structure of the sun without any experimental verification.[8,9] In 1926, he would speak hypothetically about being able to live on an isolated planet completely surrounded by clouds. In such a setting, he thought he would still be able to analyze the sun without any further knowledge than its mass, its size and the laws of physics.[8,9] It was in this spirit that Eddington set out to expand on Lane's model of the sun. Assuming that Lane's gaseous model was correct,[7] Eddington used simple deductive reasoning to set the internal temperature of the sun at 10,000,000 - 40,000,000 K.[8,9] Today, this remains the range for the internal temperature of the sun (~15,000,000 K). This accepted temperature is reinforced by man's knowledge of the temperatures associated with thermonuclear energy.

At the same time, Eddington also realized that a gaseous sun should collapse on itself.[8,9] That is, the great forces of gravity present on the sun should pull all of the mass of the sun into a much smaller sphere. Like his predecessors, Eddington pondered how it was that the gaseous sun did not collapse. He solved the problem by invoking outward radiation pressure originating from within the sun. He reasoned that if the inside of the sun was producing individual packets of light (or photons), that these photons could in turn produce the outward pressure he was seeking. It was already known that light pressure (or radiation pressure) could be measured on earth. For instance, a thin foil could be caused to rotate when exposed to light. Therefore, light quanta clearly possessed momentum. It was this "light pressure" that Eddington would invoke to keep the gaseous sun from collapsing.[8,9] Consequently, Eddington postulated that the inner portion of the sun produced photons. He then deduced that these individual light quanta would sooner or later run into a gas ion or atom and propel it up against the forces of the sun's gravity. He called the region of the sun where this occurs the radiation zone. This zone remains a central portion of solar theory to this day. Importantly, however, this zone exists primarily as a result of Eddington's reasoning.

While Eddington believed that he properly understood a key aspect of solar theory with the creation of the radiation zone, he also wanted to know exactly how many photons the sun could produce to support this hypothesis. At the time, he understood the consequences of Stefan's Law of Emission.[10] Stefan's Law states that the total amount of photons (or light) emitted from a perfectly emitting object (a blackbody) is directly proportional to the fourth power of the object's temperature ($\varepsilon = \sigma T^4$, where ε represents total emission and Stefan's constant, σ, is equal to 5.67051×10^{-8} Watts/(m^2K^4)). It was through Stefan's Law that Eddington sought an answer. Believing that the internal layers of the sun could be treated as individual blackbodies, Eddington could apply Stefan's Law to imaginary internal solar layers. He could construct hypothetical spheres within the sun and calculate the total amount of photons emitted from such spheres. Given the dimensions and temperatures involved, the total output of photons would be almost unimaginable. Not fully understanding the limitations set down by Kirchhoff, Eddington believed that Stefan's Law was universal. In the end, Eddington's application of Stefan's Law would result in a tremendous output of photons from the sun. Yet, the sun is known to have a much lower total energy output.

At the same time, Eddington recognized from the laws of thermodynamics that an object at millions of degrees should produce its photons at X-ray frequencies. This was preordained by Stefan's Law of Emission,[10] Wien's Law of Displacement[11] and Planck's Blackbody Radiation Law.[6] However, Eddington also realized that the sun emitted very little X-rays. Indeed, most of the solar output of energy occurs in the so-called "visible region." That is, the sun is producing its energy primarily at frequencies easily detected with the human eye. This energy output is emitted from the surface layer of the sun, called the "photosphere."

In the mid-1880's, it was Langley[12,13] who first recorded the output energy of the photosphere. He pointed a detector directly at the sun and recorded, for the first time, its emission spectrum. At the time that Langley obtained this data, he immediately recognized that the solar spectrum had a thermal appearance. As such, overextending Kirchhoff's Law, Langley would seek to apply the Laws of Thermal Radiation to the analysis of the solar spectrum. First, he assumed that the sun was nearly a blackbody. Once again, by ignoring the constraints set forth in Kirchhoff's Law of Emission, he was able to set the temperature of the photosphere. Without regard for the phases of matter, he reported a temperature of ~6,000 K. As a result, even though the Laws of Thermal Emission were developed in solids, the value of ~6,000 K remains the accepted temperature of the photosphere to this day.

It can be said that Langley's experiment was the beginning of a new age for astronomy.[12,13] For the first time, the emission spectrum (plot of the intensity of light as a function of frequency) of a star had been recorded. When Eddington was working on his theory of the gaseous sun,[8,9] he was well aware of Langley's temperature for the photosphere (~6,000 K). Yet, Eddington had deduced that the internal portion of the sun was at temperatures of millions of degrees. Furthermore, these photons should be produced at X-ray frequencies. In order to solve this dilemma, Eddington simply stated that when photons are produced in the radiation zone, they are initially produced at X-ray frequencies.[8,9] However, when these photons are absorbed in the collisions associated with radiation pressure (see above), they slowly lose some of their energy. In this manner, after millions of years and many collisions, the photons emerge from the sun's photosphere shifted to the visible region. Only a very small fraction of the total photons produced in the absorptive zone manage to escape at any time. According to Eddington, the radiation zone is acting as a very slowly leaking "sieve."[8,9] It was in this manner that Eddington was able to solve some of the great problems in solar theory: 1) How to prevent the gaseous sun from collapsing on itself; 2) How to set the internal temperature of the sun and finally; 3) How to shift the frequency of photons produced at X-ray frequencies to the observed visible region. The creation of the radiation zone had resulted in tremendous radiation pressure within the sun. For Eddington, this radiation pressure exactly balanced with the gravitational forces resulting in our current gaseous model of the sun. The gaseous sun had been prevented from collapsing and photons were now produced appropriately in the visible range.[8,9] Thus, Eddington's gaseous sun was at very high temperatures (millions of degrees). Yet, this extremely hot object, was surrounded by a very cool photosphere only a few thousand kilometers thick and at a temperature of just ~6,000 K.

It is interesting that in Eddington's model, the inside of the sun is unable to heat the photosphere. If the sun was a tennis ball, the entire ball would be sitting at millions of degrees. Furthermore, it would be surrounded by a layer, on the order of skin deep, at ~6,000 K. How can the photosphere be so cold relative to the inside of the sun? It is hard to conceive that such an object can exist. In addition, the primary means of heat transfer within the sun, as proposed by Eddington, remains radiative in nature.[8,9] That is, photons become the primary means of striving for internal thermal equilibrium in the sun. However, this idea is not in accordance with our knowledge of the behavior of objects. Rather, for all other objects, internal thermal equilibrium is achieved through thermal convection and conduction. In contrast, radiative heat transfer enables an object to dissipate heat and try to reach thermal equilibrium with the outside world.

It can be argued that much of modern solar theory can be attributed to ideas first developed near the beginning of the 20th century by men like Lane, Langley and Eddington. Today, Eddington's radiation zone remains as a central feature of solar theory. The sun is viewed as composed of a very hot internal fraction (>10,000,000 K) surrounded by Langley's photosphere at ~6,000 K. The density[14] of the central core is thought to approach 150 g/cm^3, while that of the lower photosphere is thought to be on the order of 10^{-7} g/cm^3. Neither of the numbers, of course, can be verified by direct experimentation.

The next big step in solar theory came in the 1950's. At that time, scientists were beginning to obtain interesting data from the solar corona (the outer gaseous layer of the sun that is seen during eclipses). The corona extends from the chromosphere (the layer just above the photosphere) to millions of kilometers away from the sun. It was observed[15] that the corona possessed within it highly ionized ions which can only be produced at temperatures well in excess of 1,000,000 K. (The width of Lymanα lines further demonstrates that temperatures in the corona range from 2.6 x10^6 K at 1.5 solar radius to 1.2 x10^6 K at 4 solar radii[15]). This finding of very hot temperatures in the corona presented a major problem for solar theory. Thus, a temperature within the corona (>1,000,000 K) which exceeded that of the photosphere (~6,000 K) indicated a violation of the 2nd Law of Thermodynamics. That is, heat could not be coming from inside the sun to heat the corona, while remaining incapable of heating the photosphere. Thus, if the photosphere was really at ~6,000 K, there must be found an alternative means to heat the corona. It has now been widely accepted that the local heating in the corona occurs as a result of a process involving the flow of ions through the magnetic fields of the sun.

Thus, the current modern model of the sun is extremely complex. The sun must generate enough internal radiation pressure to prevent a gaseous sun from collapsing on itself. The model must also contain photons. It must shift the photons produced at X-ray frequencies to the visible region. Furthermore, in order to simultaneously preserve Langley's temperature and respect the 2nd Law of Thermodynamics, the model must provide two means of generating heat. The first of these must occur within the sun and is thought to be thermonuclear in origin. The second must occur in the corona and is thought to be of magnetic origin. Particles moving at enormous speeds must also be involved to ensure this second temperature. Furthermore, something very strange must be happening relative to the photosphere. Indeed, the model advances that this layer cannot be heated either by the interior of the sun or by the corona, both of which are at much higher temperatures. It is under this backdrop that the modern theory of the sun has developed and few, if any, have questioned the initial findings or assumptions.

3. The Liquid Model of the Sun:

The sun cannot meet the requirements for a blackbody as set down by Kirchhoff for the simple reason that it is not in thermal equilibrium with an adiabatic enclosure. In fact, the sun is actually operating far out of equilibrium by every measure. As such, it is improper for Langley[11,12] to set a temperature of the photosphere at ~6,000 K based on Stefan,[10] Wien[11] and Planck.[6] Moreover, the photosphere cannot be a low density gas. Gases simply cannot produce a Planckian shaped thermal emission profile like that seen in the visible light provided by the sun's photosphere. Rather gases emit or absorb radiation in narrow frequency bands often reflecting quantized vibration-rotational states. There does not exist a single example on earth of a pure gas producing a Planckian shaped emission spectrum. This is reserved for solids and liquids since only they possess the structure required to support the vibrational modes leading to a Planckian shaped emission spectrum. The belief that isolated gases can support a Planckian shaped spectrum is erroneous. Also, the photosphere cannot be a solid as convection currents are clearly observed in this layer. That is, there is clearly the flow of material in the photosphere.

This leaves the liquid state as a prime candidate for the photosphere. The sun has an average density of 1.4 g/cm^3. This fact can easily support a liquid model. By comparison, the density of water is 1 g/cm^3. In addition, a liquid structure eliminates the need for radiation pressure to prevent the sun from collapsing on itself through the forces of gravity. The liquid alone can support the upper layers.

It is advanced that the temperature reported by a Planckian emission profile depends only on the amount of energy contained in the vibrational degrees of freedom of the lattice. Liquids still possess the vibrational degrees of freedom required for generating a Planckian shaped emission profile. However, in a liquid, not all of the energy is contained within the vibrational degrees of freedom of the lattice. Indeed, most of the energy (nonnuclear) may well be contained in the translational and rotational degrees of freedom. This leaves much less energy than expected at a given temperature in the vibrational degrees of freedom of the lattice. This fact can cause a liquid to report a much lower temperature than its real temperature when the Laws of Thermal Emission[6,10,11] are utilized to monitor its emission spectrum. Since the frequency and amount of photons released by an object is related only to the amount of energy in the vibrational degrees of freedom of the lattice Evib, it is easy to see why Langley was tricked into thinking that the photosphere was sitting at a temperature of only ~6,000 K. A liquid can instantaneously lower the total output of photons at a given temperature and releases them at a frequency significantly lower than what would be predicted from the real temperature of the liquid. Thus, a liquid photosphere with a temperature of ~7,000,000 K could be generating photons not at X-ray frequencies as expected, but rather, in the visible range. This occurs because the photosphere is a liquid and has convection. Since most of the energy of the photosphere is tied up in the translational (or rotational) degrees of freedom and its associated convection, it is simply not available for the generation of thermal photons. Langley failed to understand the importance of Kirchhoff's adiabatic enclosure.

As such, the photosphere is once again "tricking us." Because it is a liquid, it is really at a much higher temperature than it appears. Since an "apparent temperature" is probably involved, Stefan's,[10] Wien's [11] and Planck's[6] Laws need to be modified. In these equations, there is a temperature term (T), included. In order to apply these equations properly to a liquid, the temperature term (T) needs to be changed to an "apparent temperature," Tapp. This "apparent temperature" will not be a real temperature. Rather, the apparent temperature, Tapp, is simply the real temperature, T, divided by a constant "α" (Tapp=T/α). The constant "α" would be temperature dependent for most liquids. For the photosphere "α" is ~1,000. As such, the sun's photosphere is reporting a temperature which is nearly 1,000 times too low. Thus, there is nearly 1,000 times more energy tied up in the translational and rotational degrees of freedom of the photosphere than in the vibrational degrees of freedom. That is where the "trick" comes in and this would have been difficult for Langley to understand at the time. The liquid phase could account for the tremendous convection currents found on the solar surface by invoking the translational and rotational degrees of freedom to deal with the heat separating the real temperature "T" and the apparent temperature "Tapp."

The liquid phase provides the only means of producing a thermal radiation curve for the sun at a lower apparent temperature than its real temperature. This remedies the problem with Langley's temperature for the photosphere. Setting a real temperature of the photosphere at ~7,000,000 K eliminates the need to find exotic ways of heating the corona and permits the free flow of heat throughout the outer layers of the sun. As such, the 2nd Law of Thermodynamics is no longer violated. Photons no longer take millions of years to leave the sun,[8,9] but rather, are "instantly" released and produced at the photosphere. By invoking a liquid model with a shifted apparent temperature, the radiation zone is no longer required within the sun. This is because the massive amount of X-rays predicted by Eddington's application of Stefan's Law would never be produced. The heating of the corona by complex magnetic field interactions is also no longer required. The primary means of internal heat transfer within the sun (like every other object known to man) once again becomes convection and conduction. Since energy transfer through convection is only proportional to T and not T^4 (as was the case for thermal radiation), it can be expected that regions of nonequilibrium superheated fluid exist within the sun. A theory based on the release of superheated fluid from the convection zone could help explain much of the solar activity found on the surface of the sun (including flares and prominences). It should also be noted that the photosphere has a reasonably distinct surface. This once again is best explained if a liquid is considered.

As a note in added proof, recent SOHO satellite data[16] provides clear evidence for waves, associated with the production of a flare, on the surface of the sun. These waves are described as "resembling ripples from a pebble thrown on a pond." While the authors do not specifically state that these represent transverse waves, there can be no question that this is the case. These waves have very long wavelengths. Gases, unlike liquids, are unable to support such waves. The photosphere, therefore, must be a liquid.

In conclusion, our sun is not a complex gaseous structure straining the laws of physics and thermodynamics. Rather, it is a liquid, a turbulent sea, which like the ocean is a testament to the power, simplicity and beauty of Kirchhoff's Law.

[1] Chapman AC, Heat Transfer, MacMillan Co, NY., p. 412-413 (1967); Landsberg PT, Thermodynamics, Interscience, NY, 1961; [2] Dicke et. al, Astrophys. J. 1, 414-419 (1965); [3] Penzias and Wilson, Astrophys. J. 1, 419-421 (1965); [4] Fixen et. al., Astrophys. J. 473, 576-587 (1996); [5] Einstein A., Verhandlungen der Deutschen Physikalischen Gesellschatt 18, 318-323 (1916); [6] Planck M., Annalen der Physik 4(3):553-563 (1901); [7]. Lane JH, Am. J. Sci. Arts., Ser 2, 50, 57-74 (1870); [8] Eddington AS, The Internal Constitution of the Stars. Dover Publ., Inc. NY, 1959; [9] Eddington, A.S., Stars and Atoms, Yale Univ. Press, New Haven, 1927; [10] Stefan J, Akad. Sitzber. 79:391-428 (1879); [11] Wien W. Annalen der Physik. 1896; 58:662-669; [12] Langley SP, Mem. Natl. Acad. Sci., v. 2, 147-162 (1883); [13] Langley SP, Phil. Mag. 22:149-173 (1886); [14] Gray DF, The Observation and Analysis of Stellar Photospheres. Cambridge Univ. Press, Cambridge, 1992, p.124; [15] Livingston W. and Koutchmy S. Eclipse Science Results: Past and Present. ASP Conference Series, vol. 205, p. 3-10, 2000; [16] Kosovichev AG. and Zharkova VV. Nature 393, 28 May 1998.

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