The Derivation of the Fine Structure Constant

By

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Let me start this paper with a short discussion of a theoretical state of matter known as the Planck conditions. These conditions are well known to physicists. They are sometimes characterized by a temperature of about 10^{32}degree K. The important thing to understand about the Planck conditions is that they are a state of matter for which there is no experimental evidence. Furthermore, the Planck conditions are defined in terms of relationships between some of the accepted constants of nature. This means that the Planck conditions were discovered by a dimensional analysis and not by measurement. As an example, one can form the relationship hc/G. All of the dimensions in this relationship cancel except for mass which appears as a square. So, we take the square root, $(hc/G)^{½}$ and call it the Planck mass. The Planck time, 10^{-43} sec., and the Planck Temperature,10^{32} degree K, are also discovered by the same procedures.

Even though the Planck temperature is many orders of magnitude higher than any temperature ever observed in the real universe, the Planck conditions are the starting point for many theoretical works. Does this make sense in light of the above considerations?

What I will do in this paper is to apply these same dimensional procedures to the dimensions that appear in the Gravitational force and in the Electromagnetic force. The result of this analysis will be two new variables which I will call n_3 and n_4. The rest of the paper is an analysis of what this means. I try to show that the Planck conditions are a sort of mathematical waypoint, on the path towards a non zero theoretical coldest temperature. We will also find a new way to compute the inverse fine structure constant, and a formula that extends Einstein's mass energy equation to include electromagnetism and radiation theory.

The electromagnetic force is defined:

$$e'_f = 8.94*10^{18}*(Q_1Q_2/r^2)gcm^3/sec^2coulomb^2$$

This can be interpreted in the following way. Let $Q_1=n_1q$ and $Q_2=n_2q$, where q = $1.6*10^{-19}$coulomb/ecu. Then:

$$e_f = 2.30*10^{-19}(n_1*n_2/r^2)(gcm^3/sec^2ecu^2) \quad \text{where } e = e'q^2$$

Under this interpretation, the electromagnetic force constant e has the dimensions gcm^3/sec^2ecu^2. I am primarily interested in the dimensions, call it:

$$e = 2.30*10^{-19}gcm^3/sec^2ecu^2$$

The gravitational force is defined:

$G_f = 6.67*10^{-8} (m_1*m_2/r^2) (cm^3/gsec^2)$

Again, I am primarily interested in the dimensions, call it:

$G = 6.67*10^{-8} cm^3/gsec^2$

Divide G by e $G/e = G/e *(cm^3/gsec^2)/(gcm^3/sec^2ecu^2)$

$= G/e *(ecu^2/g^2)$

Using dimensional methods, I will create a function whose dimension is the ecu.

Take the square root $= (G/e)^{1/2}*(ecu/g)$

Multiply by m(g) $= (G/e)^{1/2}*m(ecu)$

(1) Call it n_3 $n_3 = (G/e)^{1/2}*m(ecu)$

Now multiply G*e $= (G*e)*(cm^3/gsec^2)*(gcm^3/sec^2ecu^2)$

$= (G*e)*(cm^6/sec^4ecu^2)$

Invert it $= 1/(G*e)*(sec^4ecu^2/cm^6)$

Multiply by c^4 $= c^4/(G*e)*(ecu^2)/(cm^2)$

Take the square root $= c^2/(G*e)^{1/2}*(ecu /cm)$

Multiply by λ (cm) $= c^2/(G*e)^{1/2}*\lambda (ecu)$

(2) Call it n_4 $n_4 = c^2/(G*e)^{1/2}*\lambda (ecu)$

We have created another function whose dimension is the ecu.
If we now multiply n_3*n_4 we arrive at:

(3) $n_3*n_4 = mc^2*\lambda/e$

This equation is an extension of Einsteins's famous mass energy relationship. It is important because it connects our concepts of mass, energy, electromagnetism, and radiation all together in one equation. Every student of physics should be aware of it.

However, Noting that $m\lambda = h/c$, if both Einstein and Planck were right, we get:

(4) $n_3 * n_4 = hc/e$

Here $hc/e = 1/\alpha$ and α is the inverse fine structure constant, not adjusted by 2π.

I believe that this equation is a new way to arrive at the inverse fine structure constant. I have never seen n_3 and n_4 any where else in the physics literature. Some people say that this is not truly a derivation. It probably is not overly important whether it qualifies as a derivation or merely a computation. Never the less, some of the implications seem significant.

At $n_3 = n_4$, we have:

$$n_3^2 = n_4^2 = hc/e \text{ or } n_3 = n_4 = (hc/e)^{1/2,}$$

If you plug these values into equations (1) and (2) and solve for m and λ respectively, you will discover that m and λ are the Planck mass and wavelength. This means that $n_3 = n_4 = (hc/e)^{1/2}$ at the Planck scale. See table (1) where all of my analysis is summarized.

Now let $n_3 = a*(hc/e)^{1/2}$ and $n_4 = (1/a)*(hc/e)^{1/2}$ These substitutions always returns the relationship $n_3*n_4 = hc/e$ for any "a". This means that "a" can serve as a scaling factor when one wants to move, theoretically, from one temperature scale to another. Since "a" = 1 at the Planck scale, every theoretical state of matter can scale from there. Note also that $n_3/n_4 = a^2 = 1$ at the Planck scale.

The next step is to find theoretical scale factors that lead to a very cold state of matter. There is a term in equation (3) that seems to work. In that equation, c^2/e, links our concepts of mass, energy, electromagnetism and radiation, i.e. $n_3*n_4/m\lambda = c^2/e$ and so I will simply choose "a" as e/c^2 and 1/a as its reciprocal in n_3 and n_4. However, in the context of scaling factors, c^2/e and its inverse need to be pure or dimensionless numbers. To say that the term c^2/e can be thought of as a dimensionless number, in this very limited context, should not pose any problem. I chose these numbers because they lead to a cold black body temperature of about 10^{-8} degree K. There might be a better choice for a theoretical non-zero coldest state of matter, but this is the one I chose. Where ever the truth lies, it can be describable by some "a" and its inverse, and it will be an "a" that will probably not be to "distant" from the one chosen here. My point is that 10^{-8} degree K is probably much "closer" to some minimum blackbody temperature than the Planck temperature,10^{32} degree K, is to some realistic hottest blackbody temperature.

Many years ago I came to the view that the Planck conditions might be a sort of mathematical waypoint on the road to a theoretical non-zero coldest temperature. That seems to be what the above analysis is telling us. Even if you don't agree with the limit that I chose, as temperature gets closer to absolute zero, n_3 gets smaller and n_4 gets larger.

I also came to the view that what theoretical physics really needed were more realistic non zero, non infinite limits at both the cold and hot ends of the temperature spectrum. I thought of these limits as limits to blackbody temperatures and not as the smallest or largest fundamental particles that might exist in nature. Once these limits were chosen, but not necessarily agreed to by everyone, we could argue about where the experimental limits might force us to modify the theoretical limits, but the zeros and infinities that plague physics today could then be abolished. Clearly, I have not proven that the Planck conditions are never achieved in the real world. Never the less, I chose 1/k or about 10^{15} degrees K, as a potential limit at the hot end of the temperature spectrum. This is equivalent to a frequency at the high end of the gamma ray spectrum. I do not believe that any one has reported an experimental frequency higher than 1/h or about 10^{26} cycles per second.

I think that the most significant thing that falls out of the analysis found in this paper is that it has produced an equation that can be viewed as an extension of Einstein's famous mass energy relationship. It links our concepts of mass, energy, electromagnetism and radiation.

$$mc^2 = n_3 * n_4 * e/\lambda$$

	COLD	HOT	PLANCK
TIME	$(Gh/c^5)^{1/2}(c^2/e)$	h	$(Gh/c^5)^{1/2}$
t=1/f	5.26382E-04	6.62608E-27	1.35122E-43
FREQUENCY	$(c^5/hG)^{1/2}(e/c^2)$	1/h	$(c^5/hG)^{1/2}$
f=1/t	1.89976E+03	1.50919E+26	7.40073E+42
ENERGY	$(hc^5/G)^{1/2}(e/c^2)$	1	$(hc^5/G)^{1/2}$
E=hf	1.25880E-23	1	4.90378E+16
MASS	$(hc/G)^{1/2}(e/c^2)$	$1/c^2$	$(hc/G)^{1/2}$
$M=hf/c^2$	1.40060E-44	1.11265E-21	5.45621E-05
WAVELENGTH	$(hG/c^3)^{1/2}(c^2/e)$	hc	$(hG/c^3)^{1/2}$
$\lambda=ct$	1.57805E+07	1.98644E-16	4.05084E-33
TEMPERATURE	$k^{-1}(hc^5/G)^{1/2}(e/c^2)$	1/k	$k^{-1}(hc^5/G)^{1/2}$
T=E/k	9.12E-08	7.24291E+15	3.55177E+32
n_3	$(hc/e)^{1/2}(e/c^2)$	$(hc/e)^{1/2}(G/hc^5)^{1/2}$	$(hc/e)^{1/2}$
$n_3=(G/e)^{1/2}(m)$	7.53235E-39	5.98377E-16	29.34309647
n_4	$(hc/e)^{1/2}(c^2/e)$	$(hc/e)^{1/2}(hc^5/G)^{1/2}$	$(hc/e)^{1/2}$
$n_4=(c^2/(Ge)^{1/2})*\lambda$	1.14309E+41	1.43892E+18	29.34309647

ENERGY CONCEPTS

mc^2	1.25880E-23	1.00000E+00	4.90378E+16
n_3n_4e/λ	1.25880E-23	1.00E+00	4.90378E+16
hf	1.25880E-23	1.00000E+00	4.90378E+16
n_3/n_4	6.58945E-80	4.15851E-34	1

Learning to love disequilibrium

It is often said of Albert Einstein that he spent the last half of his life trying to unify gravity with electromagnetism, but was never able to achieve it. Since my discovery of the equation found on page 4, i.e., $mc^2 = n_3 * n_4 * e/\lambda$, where $n_3 * n_4$ always equals the inverse fine structure constant. I have often wondered if he knew of this equation. It is my belief that he did not because this equation goes a long way towards the unification that he was looking for. I believe that if he had known of this equation he would have brought it to the attention of the physics community and would have come to some of the same conclusions that I will attempt to justify here. The first part of this paper which was published on 12/11/2014 is included exactly as it was published back then. These new pages are now added because I have had time to reflect, and think that what I had written back then needed an update and clarification, but no change.

Let me draw your attention to page 5. There are three columns with three possible states of matter, including three different temperatures represented there. All of these states are built from the known constants of nature alone. I will argue that these represent a sort of template, when coupled with knowledge gained about the inverse fine structure constant and a well known observation will lead us to a workable more realistic cosmology. It would be a cosmology that can summarize the essence of how our universe works. It would also create a new paradigm for cosmology

The view of the universe that I am proposing centers on the limits that I proposed earlier in that older version of this paper, but also, repeated here. I believe that these limits are probably not absolutely correct but by arguing that they might be close, a new, more correct, view of physical reality might be established.

When the two new variables, n_3 and n_4 are multiplied together they always produce the inverse fine structure constant. This means that any temperature can be thought of as a mixture of radiation and matter that produce the inverse fine structure constant but the mixture is always different for different temperatures. I think that the discovery of n_3 and n_4 will open the door to a new view of the universe that gives us a better overview of how it actually works.

When I look at the physical ideas presented in the columns presented on page 5, what I notice is that there are two different energy concepts but only one temperature concept. It would appear, by just considering the constants of nature, the universe should always be in a state of thermal equilibrium, hence a heat death. There is no explicit mechanism for change mentioned here, but there are many different possible temperatures and temperature differentials in the real world. The universe is not currently in a heat death, so something appears to be amiss when we look closely at the constants of nature. They don’t include, at first glance, any real physics. Real physics requires temperature differentials. These conditions don’t tell us how the universe changes. Clearly, we can find a single temperature that might, in some sense, represent the temperature for the entire universe, i.e. a cosmologic temperature, but could such a single temperature represent a realistic cosmologic view. I don’t think so.

When we look out at the universe, what do we see? We see dark patches and bright patches. I think that virtually every physicist would agree that the dark volumes represent volumes that are colder than the volumes that are bright. The bright volumes are volumes that contain stars and galaxies and the dark volumes are volumes that contain fewer stars and galaxies, and probably, in most volumes, no stars and galaxies at all. This tells me that there are probably at least two different averaged out temperatures that could represent the world better than a single averaged out temperature. I think that the astrophysicists could make pretty good estimates for these two averaged out temperatures right now.

For the energy limits that I suggested, n_3 run roughly from 10^{-39} to 10^{-16}, and n_4 runs roughly from 10^{18} to 10^{41}. Notice that n_3 is always unequal to n_4 throughout the given energy range, but n_3 times n_4 is always equal to the inverse fine structure constant at any temperature. When n_3 is at a maximum, n_4 is at a minimum and when n_3 is at a minimum, n_4 is at a maximum. Also note for a cosmology characterized by at least two temperatures n_3 and n_4 would be different for dark volumes than they would be for bright volumes. If, for example, a bright volume should produce a photon and that photon moved from a bright volume to a dark volume the temperature of both volumes would be affected, and both n_3s and n_4s would, individually have to change. When you multiply n_3 times n_4 for each new region, both would equal the inverse fine structure constant, but the mixture of matter and radiation would now be different than they were before the photon was produced and moved.

The Planck Conditions

By applying a dimensional analysis to the gravitational force, and the electromagnetic force constants, I found that there was an inverse fine structure constant that was applicable to the Planck Conditions. In fact, the condition n_3 equals n_4 can be utilized to define the Planck Conditions. This inverse fine structure constant is a function of the known constants of nature alone. It was also derived from a two energy one temperature view of nature. It represented the only possible equilibrium temperature where n_3 is equal to n_4, i.e. where the mixture of matter and radiation would be such that the temperature of all volumes would be the same, i.e., a true heat death, so in my mind it represented the only possible conditions in the universe where a true heat death would be possible, but the Planck temperature is a temperature that can never occur in the real world because n_3 is always unequal to n_4 for realistic temperatures. For realistic temperatures n_3 and n_4 never approach the n_3 and n_4 of the Planck Conditions. To my mind, what this means is that the universe is not now, never has been, or never will be in a heat death, for if it did, it would seem to be in a permanent heat death at the Planck temperature. I believe that this is the true message of the inverse fine structure constant, when in a relationship with the Planck Conditions. This is the mystery of the inverse fine structure constant. If this is the true meaning of the Planck Conditions, I see nothing in the Planck Conditions that says any thing at all about the beginning of the universe, or for that matter, the universe at its minimum size. I also came to the view that two energies coupled with a minimum of two temperatures would produce a cosmologic model that would be a more realistic cosmology, than a two energies coupled with a single temperature cosmology. It would allow the universe to continue to evolve, because it could never reach a pure state of equilibrium. Moreover a two temperature cosmology where both temperatures are averaged over the many temperatures and differential temperatures of the real world might produce a cosmology with a much narrower range than the range suggested on page 5. The two energy concept, coupled with a one temperature concept leads us to an unrealistic temperature. That temperature is the Planck temperature. It forces us to reject the two energy one temperature universe. In a universe with temperature differences, the Planck Conditions can not exist. The Planck Conditions represent an unrealistic heat death not the beginning of the universe.