MICROWAVE BACKGROUND RADIATION, ENTROPY AND THE COSMOLOGICAL CONSTANT.

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In my previous paper, 'The Large Scale Structure of the Universe' and 'The Treatment of Space as a Solid Structure', I described the the structure of space and time and their relationship to the fundamental constants of physics and particularly to the Cosmolgical Constant or the so-called Lambda factor.

There were however, two topics which I did not address namely Universal Entropy and the Microwave Background Radiation. In this paper I intened to show how both are related to the Cosmological Constant.

To summarise briefly, the Cosmological Constant describes a Universe whose radius is shown to be $\frac{1}{2}c^2$ light years. This Universe has a geometry which is flat, it's dimensions and radius are described by expressing time as a function of the kinetic energy of a galaxy moving through space in a repulsive gravitational field and by the relativistic addition of the veleocities of two galaxies A an B receding from each other i.e:-

$$V_{AB} = \frac{V_A + V_B}{1 = \sqrt{\frac{V_A V_B}{c^2}}}$$

My two paper dealt with the intimate relationship between the largest and smallest structures of matter and described an approach to the quantization of gravity by treating space as if it was a solid whose internal structure is is defined by gravitational potentials spaced equipotentially throughout the structure.

However,there are two important topics which I did not address previously but which must be fundamental to any coherent theory of the general structure of space-time, as mentioned these two subjects are Entropy and the Cosmic Microwave Background Radiation and I will deal firstly with Entropy.
I have always been puzzled by this subject in that, in broad terms,the theory tells us two things, the first being that the disorder of a system

increases with time and secondly that a system is in it's maximum state of disorder when it is in a state of thermal equilibrium. What which puzzles me particularly about the Second law is that this is simply not our experience. Despite what the Law may tell us, we see around us a manifest increase in order through the evolution of ever more complex life forms. In cosmology we believe we are witnessing the evolution of ever more complex structures from disordered beginings in that modern cosmolgy asks us to accept that on the one hand the universe has evolved from a disodered state into an ordered state. However, modern physics asks us to accept that the most probable state of any system is that of thermal equilibrium, Cosmologists tell us that the reason for this state of affairs is that gravity is always attractive and it is from this point onwards I move into dangerous territory.

In the past I have drawn heavily on the work of Sir Arthur Eddington who once famously said ----'but if your theory is found to be against the Second Law of Thermodynamics there is nothing for it but for your pet theory to collapse in deepest humiliation'.

Unfortunately for Edddington, the existence of the Cosmological Constant will serve to cause us to re-examine the validity of the Second Law or at least to formulate it in another way. Let us first write down the definition of the Second Law. It is:-

The Entropy of an isolated system is increases with time, *or remains constant with time.* (The italics are mine.) The Second Law can be worded as :-

'For any process taking place within the Universe, the entropy increases if the process is irreversible or remains constant if the process is reversible.'

In other words, for any process taking place within the universe, in which the entropy increases, is irreversible or remains constant if the process is reversible.

More generally, in the Second Law the term 'Universe' is applied to a system and it's surroundings and the total change in entropy is given as :-

$$\Delta S_{(univ)} = \Delta S_{(sys)} + \Delta S_{(surr)} \qquad (1)$$

and generaly this is taken to mean that:-

$\Delta S \geq 0$ (2)

In other words, every irreversible event that occurs in the universe contributes to an overall increase in universal entropy and it is here that the increase in entropy is said to describe the Arrow of Time.

Let us examine now the entropy of the Universe itself as opposed to it's component parts S_{sys} and $S_{surr.}$.

There is a change in entropy when an ideal gas undergoes an expansion from volume V_1 to volume V_2 . Similarly, as the Universe expands one would assume that one could apply the same principle to the expanding Universe. Indeed one can, however the result of doing so is radically different to that which would be expected when applied to conventional thermodynamic theory.

Turning firstly to the question of theexpansion of the universe and the change in volume from V_1 to V_2 . In a steady state model, there is no change in volume as such, however this does not mean that the volume of the universe should be a straightforward calculation of $V = \frac{4}{3}\pi R^3$ since V_1 is equal to V_2 we can apply the expression $S = k \ln \frac{V_2}{V_1}$ and we can write $S = k \ln V$ where V can be normalised to 1 and thus we can write:-

$S = k \ln V$ (3)

Thus $S = k \ln 1$ from which it follows that $S = 0$.

The same conditions can be said to apply to an expanding model of the universe because in this type of model the relative volume of the universe always remains the same at any given moment of time because the universe is not expanding from one volume to another.

I referred earlier to the conditions described in 'Big Bang' cosmology in which entropy is said to be high in organised states of matter and low in dis-organised states which, of course, is in complete contradiction to general thermodynamic principles. Let us examine this hypothesis more closely.

In any symmetrical space-time, there is no tidal distortion, the Weyl tensor is equal to zero and the Ricci tensor is equal to infinity, and it is this condition that provides a space-time of low entropy. Thus it is not the universal attraction of gravity which provides a low entropy space-time, it is the existence of a state where the Weyl tensor is equal to zero. I repeat, Gravitational attraction is not the source of low entropy. The source is any situation in Weyl = 0 and Ricci = ∞ which is exactly the condition described when invokng the Cosmological Constant. Indeed it is the case that any condition where Weyl = 0 indicates the arrow of time.
Since the tensor Weyl = 0 and the tensor Ricci = ∞ represents a state of equilibrium (or a steady state) we can express Equ. (3) as a probability function as follows.
If a system is not equilibrium it is said to be in a state of lower probability than if it was in equilibrium and generally a system will evolve until it attains a state of maximum probability. Furthermore a system can only truly be in equilibrium if it is totally reversible. The probability of a thermodynamic state is given by :-

$S = k \ln P$

where p is a state of probability from 0 to 1. Substituting from Equ.3, since $S = 0$ it follows that $P = 1$. Thus it follows that the steady state Universe is in fact a reversible system, reversing through its own internal reflection in a manner outlined in my previous paper 'The Treatment of Space as a Solid Structure' and the congruence of space-time is preserved.

In order to quantify entropy in more precise terms it is necessary to evaluate the subject mathematically.
In the extreme case of gravitational attraction i.e. a black hole, the entropy of a black hole is proportional to its surface area. The elementary relation between mass and area is given by :-

$A=16\pi M^2$ and we can write:-

$S=4\pi M^2=\frac{1}{4}a$ and the entropy of a black hole can be written as :-

$S = \frac{kAc^3}{4\hbar G}$.

In the extreme case of gravitational repulsion the inverse is true and the entropy of the entire universe can be written as :-

$$S = \frac{4\hbar G}{kAc^3} \qquad (4)$$

The radius of the universe is $\frac{1}{2}c^2$ light years which is equal to $4.26x10^{32}$ metres, thus its internal surface area is $2.28x10^{66}$ square metres. It follows from (4) above that the total entropy of the universe is :-

$$\frac{4x1.05x10^{-34}\ x6.72x10^{-4}}{1.3805x10^{-23}\ x2.28x10^{66}\ x2.7x10^{25}} \approx 0$$

Alternatively universal entropy can be written as :-

$$S = \frac{\hbar c}{M^2 2\pi kG} \approx 0$$

Here $M = \frac{R_0 c^2}{2G} = 2.88x10^{59}\ kg.$.

There are two major inferences to be drawn from the foregoing the first being that entropy increases with distance. Secondly, since the entropy of the Universe is thus shown to be zero (at least to the closest possible approximation) it follows that the entire system of the universe must be reversible and I maintain that this is due to the total internal reflection of the system.

The next major topic of this paper is to examine the question of the Microwave Background Radiation with particular reference to the Cosmological Constant.

Generally the temperature of space or the 'Microwave Background Radiation' is taken to be some $3^0\ K.$ to a close approximation.This temperature has a wavelength give by Wien's Displacement Law :-

$\lambda_{\max} T = 2.898x10^{-3}\ M.K.$ where $2.898x10^{-3}$ is Boltzmann's constant.

Using Wien's Law we can calculate the frequency of the $3^0\ K.$ Microwave Background to be approximately $3.11x10^{11}\ Hz.$ and the wavelength to be approximately $9.66x10^{-4}\ Mtrs.$ How does this fit into a universe driven by the Cosmological Constant ?
Again we can use the extreme equations of attractive gravity. A Black Hole behaves as if it's temperature in inversely proportional to it's mass i.e.

$T=\frac{k}{2\pi}$ where $k=\frac{1}{4}M$

$\therefore T=\frac{1}{8\pi M}$ (5)

Inverting (5), the additive temperature of the entire Universe is :-

$T=8\pi M$ where $M=2.88x10^{59}\ kgs.$

$\therefore T=7.24x10^{60}\ K.$

Using Wien's Displacement law we can write :-

$$\lambda=\frac{2.898x10^{-3}}{7.24x10^{60}} = 4x10^{-64}\ mtrs.$$

and the frequency as :-

$$f=\frac{3x10^{8}}{4x10^{-64}} = 7.5x10^{71}\ hx.$$

In my paper 'The Large Scale Structure of the Universe' I calculated the the average mass density of the universe to be some $7.63x10^{-40}\ kg.m^{-3}$. Utilising this figure we can proceed as follows to calculate the temperature of this mass density :-
Since $E = mc^2 = hf = h\lambda$ we can write as follows;-

$$E = mc^2 = 7.63x10^{-40}\ x\ 9x10^{16} = 6.867x10^{-23}$$

$$f = \frac{E}{h} = \frac{6.867x10^{-23}}{6.256x10^{-34}} = 1.036434436x10^{11}\ Hz.$$

and

$$\lambda = \frac{3x10^{8}}{1.036434436x10^{11}} = 2.894539x10^{-3}\ mtrs.$$

$$\therefore\ T = \frac{2.898x10^{-3}}{2.894539x10^{-3}}$$

$$= 1.0011957^{0}\ K.$$

A very close approximation to the observed Microwave Background Radiation.

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