Origin of the universe: Relativistic particles dynamics and entropy produced the exponential inflationary epoch

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ABSTRACT

Einstein's relativity ideas have not yet exhausted their applications to elucidate the physical realities of the universe and will be demonstrated to have been instrumental in the origin of the cosmic inflationary epoch for which there is still no clear explanation. The biggest problem in cosmology is our current ignorance about what preceded time 0 of our cosmological history. Moreover all published concepts about how a universe or universes could originate are highly speculative and simplistic. For this reason this paper is one of a series dealing with the micro and macro scale realities of the universe which aim to eventually lead to a proper and self-explanatory concept of the origin of our universe right from whatever could have preceded time 0. Pending this new concept we agree with the generally accepted occurrence of the Planck epoch followed by a grand unification epoch up to 10x -36 s to be immediately followed by the inflationary epoch. Minkowski's reputed space/time statement that space and time being separate entities was doomed could evolve towards the realization that energy, matter, and gravitation might all together constitute an independent integrated reality of its own which encompasses the basis of consciousness in all its expressions. Such an integrated reality, intimately linked to the mechanism which created our universe, could, we are quite confident, help us to eventually understand the scientific basis of what constitutes metaphysics. Anticipating this possibility we show how Einstein relativity is still alive in the new concept, we report here, of the inflationary epoch believed to have occurred sometime at 10x -36 s after the appearance of the initial energy mass which would produce the universe. The initial pure energy, soon after time 0 with c as average velocity, should have an infinitely contracted space-time and would, in the presence of, first, a small fraction of massive hadron particles, inevitably begin inflating cataclysmically and exponentially. The successive formation of another small fraction of leptons like electrons, positrons and others would accentuate this inflation. We show that Einstein's special relativity theory and the second law of thermodynamics, also called the law of increased entropy, satisfactorily explain the exponential inflationary epoch.

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INTRODUCTION

"The effort to understand the universe is one of the very things that lifts human life a little above the level of farce, and gives it some of the grace of tragedy." Steven Weinberg, Nobel Laureate (1979) in his book: The First Three Minutes.

de Sitter (1), and Friedmann (2) had suggested, amongst other observations, that the universe could be expanding. Extending Einstein's general relativity (3),Lemaitre (4,5) was the first to argue that an expanding universe must have been earlier more compact, more and more so as we go further and further into the past to lead eventually to what he called a primeval atom, which contained all the matter of the universe and which subsequently expanded into the universe. Lemaitre's ideas were refined by Gamow (6,7) and by Alpher and Herman (8) in the 40s into a hot big bang where Lemaitre's primordial atom was replaced by a hot soup of particles and radiation. Extrapolating the expansion of the universe backwards in time, based on general relativity, would progressively lead to a small and denser universe until we have an infinite density and temperature at a certain time in the earliest stages of the universe and not earlier than the Planck Period. The nature of the earliest hot dense state before the Planck Period is not understood but it is primarily this state that is known as the Big Bang. No real progress has been made on how such a primordial mass of energy could have evolved into our universe with its incredible micro and macro structures which have endowed it with the realities of existence we can hardly believe and rationalize from a scientific and philosophical point of view.

These early notions of an expansion of the universe were dramatically extended by Guth (9,10,11) , Linde(12,13)and by Albretcht and Steinhardt (14)who firmly established an exponential inflation as an important stage of the big bang theory. The inflation theory has by and large explained some of the unsolved problems of cosmology, inherent in the hot big bang theory, like the flatness and horizon mysteries. The gist of the inflationary theory is a period of rapid exponential expansion very early during the first second of the origin of the universe presumably at s 10^{-36}. The usefulness of the inflationary concept probably has deeper explanations in the sense that it is one major logical mechanism in a series of initial steps that were meant to produce our universe having the kind of realities it has.

Now it is quite likely that the elucidation of the origin of the universe could indicate that energy, matter, motion and gravitation all together constitute an independent integrated reality of its own which encompasses the basis of consciousness in all its expressions, and if properly understood the mechanisms of the creation of this kind of reality could lead us to eventually understand metaphysics in a clear scientific language. If scientifically resolved based on new acceptable concepts then such intriguing scientific overtures, when they are formulated, will address some of the limitations of science raised by Ellis (15) where he highlighted the inability of even the most advanced physics to fully explain factors that shape the physical world, including human thoughts, emotions and social constructions. We have seen some interesting new concepts of our realities of which a bold one is Hameroff

and Penrose's Orch OR (Hameroff and Penrose 16; Hameroff and Penrose 17), based on self organizing biological quantum computing systems. One of the biggest stumbling blocks with this concept is the sequestration of quantum states from environmental decoherence but in this concept it is the reduction or collapse of the quantum states by environmental decoherence which is claimed to be the key trigger of converting quantum states to classical states. In other words in this consciousness concept of Hameroff and Penrose it is believed that the indeterminism of quantum mechanics is reduced to determinism of classical mechanics and the result is our consciousness. According to Penrose (18) this process requires a non-computable, non-algorithmic process but how such an approach is possible does not appear to be easily sorted out using contemporary scientific views and doubts have been expressed on its actual possibility. In addition it is not really understood what exactly is quantum coherence in the context of quantum consciousness and what is the physical reality of the classical mechanics which in this concept arise from quantum collapse. We believe that our work on a significantly more precise understanding about how the universe originated in the earliest moments of its creation, including what was possibly there before time 0, would likely throw light on what is consciousness and how we view our deepest realities of existence.

Our forthcoming concept on the origin of the universe will attempt to show that such an apparently impossible creation task, including how it satisfies the Law of Conservation of Energy, which cannot be accounted for yet by physics, might well be within our scientific capability eventually. A new approach would require an alternative to the singularity or vacuum fluctuation theory of the origin of the universe and this is the focus of our current and future research.

Einstein's relativity theories (3,19,20) and the second law of thermodynamics have significantly helped to produce insights of the nature of realities of our universe. In spite of their wide applications we still have not exhausted their possibilities in explaining the natural laws from which the cosmos could be built up. General relativity considers space and time to be a soft geometrical structure of which the shape and evolution are determined by the matter within it. However, in the last decade, a strong belief has been developing indicating that dark matter as well as normal matter together with a mysterious constituent called dark energy might be largely responsible for the accelerated expansion of our universe. Whatever be the real cause of this accelerated expansion the force responsible for it is regarded by Rees (21) quite rightly as an 'antigravitation force'. Schrabback et al (22) recently produced data which seem to confirm existence of an accelerated expansion, a prediction in support of the general relativity theory. Peerally (23) demonstrated the occurrence in Keplerian orbits of a 1:2 proportionality, reminiscent of the ratio of kinetic to potential energy in the virial theorem, between the relativistic effects of special and general relativity. The suggested affinity of relativistic effects with the virial theorem was meant to indicate an interesting correlation of relativity with kinetic and potential energy, which did not imply, however, that Einstein relativity theories can be

explained by the virial theorem. We give evidence that there exists an expanding cosmological factor responsible for inflation and expansion, as opposed to the attractive gravitational factor that creates a tendency of contraction. The expansion factor acts on the space-time physical fabric which permeates the whole universe resulting in its expansion, while the gravitational factor results in both intergalactic and intragalactic cohesion. The interplay of these opposing forces gives an impression of a stable universe, which Einstein misinterpreted as a static universe. There is in essence a net balanced cosmological situation, the resultant of the expansion and the attraction cosmological factors, which contributes in the tendency for the universe to stay coherent, although it is continually expanding due to an inexorable entropy. These considerations will be extended in a future paper to explain in no uncertain terms the quantum mechanical origin of gravitation and how that is intimately linked to the anti-gravitation emphasized by Rees. That will hopefully help to integrate the micro and the macrocosm of the universe. In so doing a number of new physics will be generated and it will be shown that the earliest moments of our cosmic existence had a real scientific basis and that will help a lot to stimulate philosophical reflections on the universe and on the realities of existence including the likely basis of consciousness and emotions.

EXPONENTIAL INFLATION

The cause of the exponential inflation is considered to be one of the big mysteries of the science of cosmology. The inflationary theories explain the origin of the universe from a vacuum fluctuation, different from the conventional big bang concept which argues that the origin occurred from a singularity of infinitesimal size, infinite energy and infinite curvature. The force behind the exponential cosmic inflation has been attributed to a false vacuum, occurring in concepts of scalar fields, with non-zero energy density, thus making the difference with a true vacuum. The critical property of the false vacuum is its significant negative pressure that in turn creates a repulsive gravitational field, as opposed to the attractive pull of gravity. It is this hypothetical negative gravitational force that is thought to have propelled the cosmic inflationary phenomenon. At the end of that epoch, due to the decay of the false vacuum according to current theories, the release of energy produces a super-hot uniform soup of particles, in a scenario that is similar to the usual big bang model of the origin of the universe. This speculative explanation is far from being adequately scientific and cannot lead to a proper understanding of our origin and that of the realities of existence. But it is possible to say at this stage that our universe has no other destiny than to eternally expand for the anti-gravitation is inexorable and has no possibility of attenuating.

In proposing a sudden exponential inflation Guth (10) is reputed to have argued that it might be possible to produce our universe from a few ounces of matter. One other facet of inflation is that it occurred much faster than the speed of light. This is naturally possible because the inflation is one of space. Inflation has received a lot of support for it contained

arguments considered by some to add credibility to the expanding big bang theory which was, already in the 80s and beyond, widely accepted as providing a logical description of the origin of our universe. However the big bang concept is incomplete particularly due to its inability yet to successfully explain, as the inflationary theory has done, the problems of flatness, horizon and magnetic monopoles of our universe. An ultra-rapid exponential inflation would stretch out any curvature and irregularities of surface to flatness. It would also bring regions which were in intimate contiguity in the past to become far removed from one another eventually and the initial isotropy would have been largely maintained in the expanded universe, except for occasional anisotropy due to very minute quantum differences in the very early stages which subsequently produced the isolated astronomical anisotropy seen in an otherwise impressively isotropic universe. It is also believed that an exponential inflation would also send magnetic monopoles formed prior to inflation far apart to undetectable levels in the present universe. In this connection the issue of magnetic monopoles will also be further speculated on in our future new concept of the origin of the universe but in a new approach

Clearly the general acceptance of the inflationary concept rapidly sent a strong signal that inflation is of fundamental importance in the early development of the universe. However it is also not yet easy to accept that the universe may have arisen out of practically nothing (24) or from a small amount of matter (10) and that a vacuum fluctuation(25), of not so obvious a possibility, could have produced all the matter of the universe. In the inflationary concept the energy of matter realized a multiplication by a factor of 10^{75} or even more due to the ever increasing negative gravitational field on which there is no limit of possibility. A major difficulty with these explanations of inflationary theories is the doubt that vacuum fluctuation is not really compatible with the law of conservation of energy mainly due to the burden on having to explain how it could have produced the totality of both the negative and positive energies of the universe. In the present paper we propose the universe at time 0 had an energy magnitude equivalent to that contained in the universe but how it was produced will be elaborated in significant details in a future paper. What is demanded by our theory in the present paper is a situation, in the original energy mass, where the initial state of pure energy becomes immediately after formation at least very partially transformed into massive particles. Under current beliefs in the earliest moment of creation very soon after time 0, a small fraction of photons produced hadrons mainly and again soon after the leptons and some other particles. Assuming that this view was in reality the case, then we argue that the provisions of special relativity and of the second law of thermodynamics can naturally, elegantly and imperatively explain the inflationary epoch, much to the credit of Guth, Linde and others who unequivocally saw the crucial importance of an exponential inflation in the earliest stage of creation.

OUR CONCEPT OF THE INFLATIONARY EPOCH

Einstein's special relativity rests on the following criteria: the speed of light is constant and speeds greater that light have no possibility of existence; with increasing velocity time dilates and space contracts; at the velocity of light space and time would have reached absolutely infinite values which is why there is no possibility of attaining the speed of light by massive particles through acceleration. The Lorentz equation shows the implication of velocity on space, time, mass and energy for a particle in motion with reference to one which is stationary and the factor gamma (Fig. 2) is determined by the equation as follows:

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

The binomial contraction of the Lorentz equation (19,23) is very useful in conveying the gist of the derivation of relativistic effects and here it will be extremely handy in showing, as concluded by Peerally (23), that relativistic kinetic energy in special relativity could be somehow, in a yet unknown way, related to all forms of relativistic effects in linear motion as shown below:

The binomial contraction of the Lorentz equation is:

$$\gamma = \frac{v^2}{2c^2}$$

Kinetic energy is:

$$\text{Kinetic energy} = \frac{mv^2}{2}$$

A relativistic effect is derived from $\frac{v^2}{2c^2}$, which is basically the kinetic energy equation, without mass, but divided by c^2 :

Thus relativistic kinetic energy or relativistic mass increase = $\frac{mv^2}{2c^2}$

Similarly substituting *m* with *t,* relativistic time dilation would be:

$$\text{Relativistic time dilation} = \frac{tv^2}{2c^2}$$

One can see that the binomial contraction of the Lorentz equation is basically the same as the equation, $\frac{v^2}{2c^2}$, traditionally used with mass for calculating the energy increase of a particle due to motion. Actually $\frac{v^2}{2}$ strongly suggests an affinity with kinetic energy by being half of v^2 which itself is equivalent to g x r, thus indicating that g x r has an affinity with potential energy, for objects in Keplerian orbits. The involvement somehow of kinetic energy, and therefore of potential energy in relativistic effects may hide important

implications which may eventually be elucidated. This is not surprising for in all accelerators and colliders experiments, the total mass of particles produced after collision is a great deal higher than the initial particles masses, so one can safely say the mass increase of relativistic particles is due to stored kinetic energy. As suggested the primordial dense lump of energy or photons just at time 0 just before time 10^{-36}s, when the inflationary epoch kick- started (Fig. 1), would have been at its apex of orderliness from the point of view of the second law of thermodynamics. The change from the absolutely contracted space and dilated time to the onset of an expanding space and contracting time, arising from special relativity and the Lorentz equation, is precisely correlated with the start of entropy as kinetic energy transforms into massive particles. Under the law of increased entropy this process must and will continue in the direction of the forward arrow of time. When very high energy photons moving at velocity *c* and a minute fraction of which giving rise to matter particles, there is a subsequent progressive deceleration of the massive particles with the liberation of more kinetic energy to produce an ultra-hot soup as predicted in both the hot big bang and the inflationary theories. Although at that very early moment matter and antimatter would be continuously annihilating, there would always be others produced instantaneously so there would be particles continuously. They would be decelerating as the universe cools down during that very brief inflationary period.

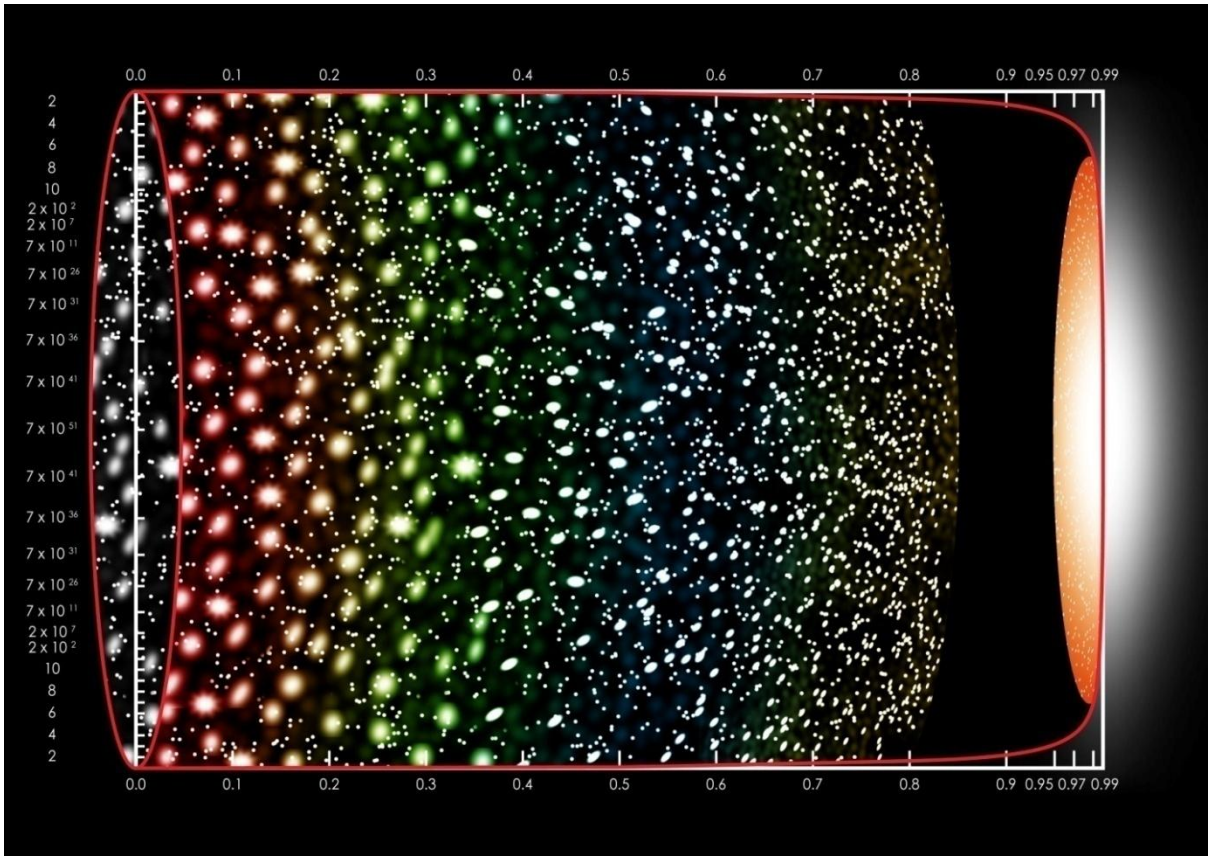

Fig. 1: The orange lens-shaped picture, with a strong glare, on the right white axis represents the inflationary epoch.The universe started from a minute corpuscle at the middle of the right axis. We present an extrapolation of the exponential inflationary universe onto the gamma factor curve (red curve) of the Lorentz equation. It shows the perfect fit of the earliest beginning of the universe and its subsequent evolution, towards the x- axis,along the contour of the Lorentz factor graph shown in Fig 2. The value of the Lorentz factor increases asymptotically from around 0.9999 c to infinity. Here we have given gamma values (arbitrarily selected but which should in reality be much higher), on a telescoped y axis, for up to 0.999 …… to 100^{th} 9 c equivalent to a gamma value of about 7 x 10^{51} . The inflationary epoch is followed by the dark ages. Even the asymptotic part of the gamma factor curve along the x-axis from 0.8 to still lower c values of average particle velocity may correspond to rates of expansion of the universe at, counter intuitively, superluminal speed. However this scheme is unable, without additional supporting evidence , to satisfactorily explain the accelerated expansion of the universe, and we need to also examine the possible implication of other parameters behind the acceleration.

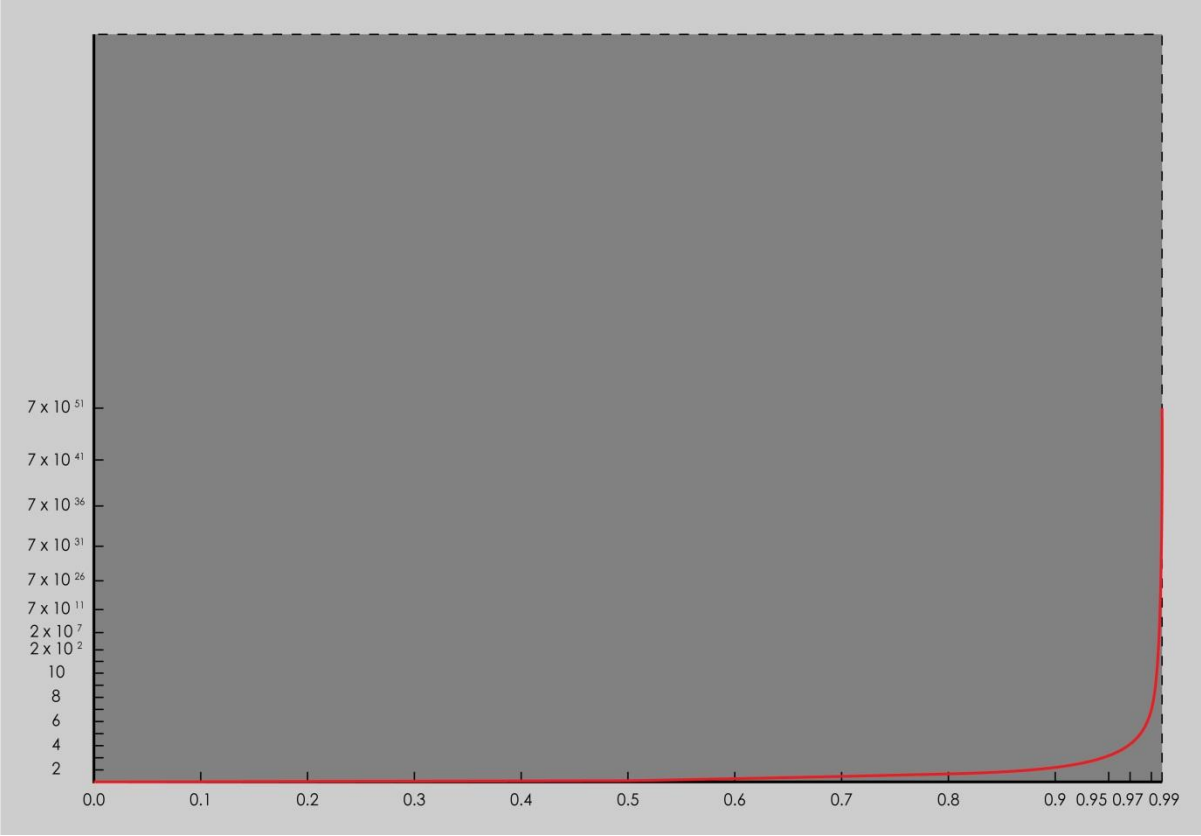

Fig. 2: Range of the gamma factor computed from the Lorentz equation against the increasing average velocity of particles as a fraction of the speed of light on the x axis. The y axis is telescoped to accommodate the extreme values as the speed gets asymptotically very near to the speed of light. The point made is as we regress from speeds very near c towards the lower speeds, massive particles, randomly distributed in the primeval corpuscle decelerate to cause first an exponential inflation and then an expansion.The gamma factor at 0.9 …..to 100^{th} 9c is around 7x 10^{51} and goes down to 7.09 at 0.99c. So in that period of deceleration from near c to 0.99c the universe would have inflated by a factor of at least10^{43} if only one photon per billion produced a particle.

Considering the mindboggling mass of particles involved, all decelerating synchronously, the very first steps as they decelerate from the speed of light, say from c down to 0.9999999…up to 100th 9 of the speed of light, then again down to say 0.9……. up to 35th 9 *c*, space time would have inflated (Fig. 1; Fig 2) by an incredibly large Lorentz factor; but that would be at least around10^{34} or even much more if most of the photons transformed into matter particles. However even if only one matter particle is produced per one billion photons, there would have nevertheless occurred an exponential expansion of at least the magnitude of 10^{25}, which would increase to an inflation of 10^{43} if the deceleration went down to 0.99cwithin the time period of $10^{-36}s$ to $10^{-35}s$. However in reality it could be even higher but we have no way of being more precise about the degree of exponential inflation. The whole universe clearly behaves here as one inertial frame of reference. In addition quantum fluctuations in the distribution of matter particles during the exponential inflation blew up to astronomical values which eventually led to the anisotropy observed in the universe.

The Lorentz equation appears to be also an equation embodying the essence of entropy. This observation has profound implications for singularity theories of the origin of the universe and for theories which predict the cyclic regeneration of the universe (26,27). The diagrammatic Lorentz/entropy equation scheme, presented below, illustrates the point being made. At 0 entropy condition, before the onset of inflation, all that existed was randomized energy in the form of high energy photons and it is suggested that any theory of the origin of the universe needs to reckon with this possibility. The theory we have presented here demands that to have 0 entropy, very early during the origin of the universe, there should have been initially a condensed mass of pure energy equivalent to the total energy of the universe.

Total entropy$\leftarrow \gamma = 1: \frac{1}{\sqrt{1-\frac{0}{c^2}}} \frac{decreasing \quad entropy \quad \rightarrow}{increasing \quad entropy \quad \leftarrow} Inflation \leftarrow \gamma = \infty: \frac{1}{\sqrt{1-\frac{c^2}{c^2}}} = 0\ entropy$

There is clearly also a cosmological principle represented by the process of the transformation of energy into matter and subsequently the progressive cooling down of the universe (28) which reduces the average velocity of particles, leading to space-time expansion. The data presented here contradict the recent claim by Gurzyadan and Penrose (29) , within their conformal cyclic cosmological aeon theory, that there was no beginning of space time and no beginning of entropy from their appreciation of the inflationary theories. In their aeon theory Gurzyadan and Penrose came up with a succession of our universe in a continuous cycle of regeneration so that the present one, in the far distant future there will be a total degeration of matter which will then regenerate a fresh universe in a new cycle. This can be shown to be highly improbable as our new concept will show in due course. The conclusion of our work adds some support to the consensus that the reported super luminal

accelerating expansion (30) of the universe might be attributed at least partially to a force to increasing entropy of matter particles. Unusually rapid entropy would lead to an accelerated expansion. Finally the asymptotic increase of entropy shown by Fig1 and Fig 2 from 0.8c to still lower c values could even represent, counter intuitively, super luminal speeds of expansion of the universe. Since the effect of gravitation is infinite in extent, any entropy everywhere in the universe could finally be seen in the remotest outside regions of the universe as a superluminal expansion. Davis and Lineweaver (30) understandably argued that the inflation and expansion of the universe could be regarded as a super luminal phenomenon.

CONCLUSION

It is likely that the exact manner the universe was created holds the secrets its realities. The exponential inflationary epoch of the earliest moment of the origin of the universe is clearly an event of vital importance for the further evolution of the universe.The gist of this paper is an explanation of the exponential inflationary epoch at the birth of the universe which was directly due to relativistic effects on the earliest initial infinitely contracted space time due to a pure mass of energy with average velocity of photon particles of c. The potential gravitational power of this initial energy containing all of our current mass of the universe would have, if left unchecked, caused the earliest state of the universe to totally collapse into a blackhole of an unknown fate. The immediate formation at that earliest moment, at time 0 continuing up to time s 10x-36 of a small fraction of elementary particles was more than needed to prevent this implosion and on the contrary to trigger the biggest cataclysmic inflation of space time to provide the earliest foundation of a macro and micro scale structure that would without impediment evolve into our universe. It is suggested that there was a point at time 0 where energy, space time, matter together with motion were integrated as a package of creation that had the budding potential for inducing the natural properties of the realities of existence which characterize our universe. This concept will be clarified in a future paper. The concept and conclusion of this work and of future papers on the origin of the universe may impact deeply on how humanity appreciates the interface of philosophy and science and on the proper elucidation of the nature of our realities of existence.

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