Journal of Cosmology, 2011, Vol 15, In press.
JournalofCosmology.com

The Quantization of Classical Fields Equations and the Cyclic Universe

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Abstract

Basically nothing is known definitely about the early universe. Einstein gravity field equation, based on general relativity and the grand unified field theories, has been employed for the study of the early universe but has not provided definitive answers. As detailed in this article, for understanding the enormous energy of the early universe, classical field equations, including general relativity, must be quantized. The quantization of general relativity by using Feynman's formulation has also faced difficulties. Unified Field theory also needs quantization of Einstein equation for studying the universe. New interpretations of the uncertainty principles indicates that physical quantities should have both lower and upper limits. Physical quantities form pairs, couple and complement to each other performing cyclic process. Their limits should overcome the limits of coupling formulae. In this article, cyclic universe theories are reviewed and limits coupling formulae are derived for pairs of physical quantities. By means of these limits coupling formulae, most of the classical field equations, including Einstein equation, are quantized. The equations derived are used successfully to describe quantitatively the whole development of our cyclic universe. Some long-standing questions in cosmology may be answered with this approach, such as the origin of quasar and the existence of other universes.

Keywords: Big Bang, cyclic universe, quantum cosmology, quantization of Einstein equation, principle of limitation and coupling of physical quantities, multiple universes

1. Introduction

The theory of the big bang, early universe has become one of the most fascinating research subjects of physics. There is a growing consensus as to happened one micro-second from the big bang. At that time, cosmic temperature was about 1 trillion ^{0}K, and the quark-gluon plasma was formed. As quark cooled, nuclei were formed, then atoms, molecules, and so on (Singh 2005; Steinhardt and Turok 2008). The standard hot big bang with inflation model is limited up to this period (Lal 2010; Masiers, et al., 1998). The big bang inflation is believed to begin at the Planck epoch of 10^{-43} sec (Singh 2005; Steinhardt and Turok 2008). What happened between the Planck epoch to one micro-second is still unknown.

Some scientists have argued that the mass of prime particles should be infinite by Einstein equation (Joseph 2010a,b). Therefore, how can those prime particles attracted to each other so tightly into a point of singularity, escape and expand to form the universe? The reason this question has not been answered is that at the development of special relativity, the limitation of physical quantities was not considered. Einstein equation needs to be quantized. We shall discuss this in greater detail later in this paper.

Physical quantities should have lower and upper limits (Ho, 2008). Equations of these physical quantities should be quantized at these environments of limits. It has been noted by Landau, Klein, and Pauli (Weber, 1961) that quantized relativity would have to be considered in elementary particle theory, at high energies. As P.G. Bergmann has remarked (Bergmann, et al., 1950), un-quantized general relativity cannot peacefully coexist with quantum theory. Its quantization may affect, in a profound way, our notions of space and time particularly in the realm of small dimensions (high energy). If a Feynman sum is carried out, over all metrics, the difficulties with the light cone may turn out to have measure zero. This indicates, unfortunately, that any quantization scheme which starts with a flat-space linear approximation will immediately have all the divergences (Bergmann, et al., 1950). It means that Einstein gravity field equation may not be applied for the study of the early universe. Indeed, it is only after the big bang and the creation of the first atoms, that physics can even be applied to this question, for up to this point, physics does not really exist.

The other difficulty, already alluded to, is the "singularity." It has been argued that if there was a singularity, this indicates the big bang was not the beginning, but a continuation (Joseph 2010a). How did a singularity first originate? One answer rests upon the quantum physics of black holes (Joseph 2010b) each of which can be considered a singularity of such compacted mass and gravity that space time becomes warped. However, it has also been theorized that energy and elementary particles are released when a black holes is formed, such that matter is recycled (Joseph 2010a,b). If this universe was created following the establishment of a singularity, then the universe may be cyclic.

Albert Einstein considered the possibility of an oscillating universe which sustains itself through cycles of creation followed by a big crunch. In this model, the universe expands until slowed by the gravitational attraction of matter, causing it to collapse. According to Tolman (1934), this model fails to take into account the entropy problem as entropy would increases due to the Second law of thermodynamics. Initially, successive cycles should grow longer and larger, with previous cycles growing shorter, culminating again in a Big Bang. If Einstein's cyclic model were correct, then the cycles would eventually come to an end, as the universe would be consumed by thermodynamic heat death.

Steinhardt and Turok (2001, 2002) have also proposed a cyclic universe by reformulating the standard hot big bang inflation model. They have proposed an endless cyclic universe model (Steinhardt and Turok 2001, 2002) where the universe comes into existence repeatedly over time. According to Steinhardt and Turok (2002), the universe expands after each big bang, which prevents entropy from building up. However, the Steinhardt and Turok (2002), model requires the existence of colliding branes and a variety of forces which exist between the branes; of which there is no evidence.

Baum and Frampton (2007a,b) have also proposed a cyclic universe which depends on hypothetical forces and phantom energies which maintains each cycle and regulates the pressure and density of each expansion and collapse. In this model, a septillionth (or less) of a second before the would-be Big Rip, everything begins to collapse except for a small patch of the universe which is devoid of elementary particles and consists only of dark energy. Thus there is no entropy. Therefore, each universe starts as empty, and as it collapses there is no matter which would cause it to prematurely spring back into existence before collapsing and beginning again as a Big Bang. The problem of the second law of thermodynamics is avoided.

Sir Roger Penrose (Gurzadyan and Penrose 2010) argues that the universe began in a very low state of entropy. Instead of an empty cyclic universe, this universe began under conditions where there was a high degree of order which gave rise to the complexity of the modern day cosmos. The low state of initial entropy indicates that the present universe was not the beginning, but is part of a cyclical chain with matter left over as each universe returns to a state of low entropy. In this model, the universe expands into eventual nothingness such that even black holes disintegrate, and the resulting highly ordered universe collapses into a singularity and the cycle begins again.

Gurzadyan and Penrose (2010) claim they have found evidence of the previous universe in the cosmic microwave background. They believe they have identified clear concentric circles within the radiation with temperature lower than those in other areas of the cosmos. Joseph (2010a) believes these concentric circles in fact surround galaxy-in-mass black holes. Gurzadyan and Penrose (2010) believes these are spherical ripples were instead created by colliding black holes in the previous universe. Key to this model is the belief that all particles will eventually lose their mass, thereby triggering the end of this universe.

Thus, central to the theory of a cyclic universe is the idea of the "big crunch"; i.e. a universe which expands, then slow, then collapses into a big crunch singularity, only to explode outward in yet another big bang, and then the expansion followed by collapse repeats itself. If the cyclic models of the cosmos are accurate, then it can be deduced that there have been infinite big bangs; a cycle which repeats itself for all eternity.

However, if the universe is cyclic, this raises yet other questions. Was the previous universe like this one? Does a cyclic universe mean that each universe is exactly like the ones that came before?

Although we cannot answer this latter question, we are provided a number of clues about the beginning of this universe. The cyclic model of Joseph (2010a,b) relies on quantum physics, including the uncertainty principle (Heisenberg 1930, 1955). According to the uncertainty principle (Heisenberg 1930, 1955), energy, time, momentum, and length must have both lower and upper limits. It is already known that energy has lower limits. Does energy also have an upper limit? It is possible time also has upper and lower limits? If so, this means the big bang cannot start from zero.

In a cyclic universe, there does exist a Planck time at the beginning of each big bang. What are the upper limits of time and length? If the length has upper limit, then our universe cannot expand to infinity and it will collapse. Each universe is finite. Another significant meaning of the uncertainty principle is that physical quantities form pairs (Heisenberg 1930, 1955). The limits of these pairs couple and complement each other to perform an everlasting cyclic processes. If we combine these principles and possibilities, this also supports the cyclic big bang model of our universe.

Several limits coupling formulae similar to uncertainty principles are derived in this paper for a number of other physical quantity pairs. By means of these formulae, many of the classical field equations can be quantized and derived equations derived can now be applied for physics at the extreme environments in cosmology. As detailed in this paper, by thermal energy and temperature limits coupling formula, a quantum thermal dynamics equation is obtained. It reduces to Planck equation exactly, as thermal energy reaches its lower limit. It can also describe the variation of thermal energy and temperature of our universe during its whole cyclic process.

Special relativity theory is somewhat related to the physical quantities and velocity limits of coupling processes. It is found that by ordinary Lorentz transformations all the physical quantities will increase as velocity increases. These findings are different from that obtained from the physical quantities and velocity limits coupling formulae; these give results showing that all the physical quantities decrease with velocity. The discrepancy may be that in their derivations from special relativity, the limitation of physical quantities was not considered. The equation obtained from limits coupling formulae may be considered as the quantized special relativity equations.

However the result from length and velocity limits coupling formula gives exactly the same as Lorentz contraction principle. Why this is so? Lorentz used a second version of the Lorentz transformation in his derivation. By this version he constructed his famous principle. Lorentz considered dx and dt instead of x and t. This means that the limitations are taken into account. Coexistence is also considered. These two are exactly what required by limits coupling formula. That is why Lorentz contraction principle is actually quantized and has the same result from limits coupling formula. This result will be discussed later in detail.

2. Significant Meanings and New Interpretation of Uncertainty Principles

The uncertainty principle of (1) does not only require that momentum has lower limit, it requires p and r having both lower and upper limits. They cannot be zero or infinity.

$$\Delta p \Delta r \sim h \qquad (1)$$

(1) is usually changed into

$$dp\, dr \sim h \quad \text{or} \quad dp \sim ih/dr \qquad (2)$$

(2) has been introduced into classical field equation and obtained quantum mechanics which has been successfully used under lower energy limit cases. The meaning of the delta's in (1) are not clear or un-certain. However, the differentials dp and dr do have clear meanings. In calculus, they mean taking limits. So (2) may be written as

$$p_{max} \cdot r_{min} = p_{min} \cdot r_{max} = h \qquad (3)$$

This requires that the limits of the pair will couple and complement to each other to perform cyclic process. When one quantity reaches its lower limit, its partner will be at its upper limit and vice versa. Their product must equal to a universal constant.

Another strong argument for supporting the uncertainty principle is the meaning of wave function. Wave function does not give clear location of the particle. It appears to give only probability of where the particle locates. The location of the particle is still uncertain. However, as we know from special relativity that for particle in motion, some of its mass will change into radiation. That means particle has dual properties, particle property and wave property. Wave function describes both these dual properties. It does not mean uncertain of the particle location.

By writing uncertainty principles into limits coupling formulae does not only avoid its misleading, it reveals that limits coupling formulae are fundamental rules of nature for ensuring that physical quantities performing everlasting cyclic processes to make stable structures for atoms and universes.

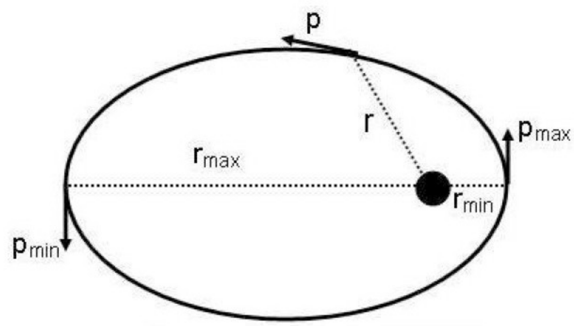

Figure 1.

To make it clearer to understand, let us consider a simple case. An electron circulates around a proton, or a hydrogen atom. P and r cannot be zero. According to (1), p and r must have both lower and upper limits. Their limits satisfy (3). As shown in Fig. 1, let us consider the electron starts from the point where r is r_{min} and p is p_{max}. Then the electron will move, r increases and p decreases according to the quantum mechanics equation. However, r and p cannot be infinity. Electron will reach another point at r_{max} and p_{min}. Then it will turn back, r decreases and p increases until it reaches the point where it started. A closed orbit is completed. (1) and (2) ensure that the electron accomplishes a closed orbit and stable atomic structure possible.

Similarly, (4) has the same meaning for energy and time. For making the meaning of (3) and (4) more clearly and avoiding controversy, they are named limits coupling formulae.

$$E_{max} .t_{min} = E_{min} .t_{max} = h \qquad (4)$$

3. Limits Coupling Formulae

3.1 Momentum and Length Limits Coupling Formula.

In the research of quantization of gravitational field, people found a quantity having the dimension of length. It can be expressed purely by universal constants.

$$L = (hG/c^3)^{1/2} \sim 10^{-33} \text{ cm}$$

It was found much too small to be directly related to elementary particle dimensions known at that time. This length is also known later as Planck length or length at Planck epoch. It will be shown later that this is just the lower limit of length of our universe or the radius of our universe at its birth.

3.2 Energy and Time Limits Coupling Formula.

Landau in his research on the quantization of general relativity, found an energy which reaches up to 10^{19} Bev (Landau, 1955). Is this the highest energy of our universe? Yes. It is. It will be shown later that it is just the energy of the prime quanta emitted at big bang. Actually this is just what Landau was looking for by his quantization of general relativity theory. Unfortunately, by that time the big bang was not discovered yet.

If this is the upper limit of energy of our universe, then by (4) the shortest limit of time of our universe will be 10^{-43} seconds, the time of Planck epoch or the time of initial singularity. Within this interval it is believed that the law of physics is useless in explaining what happened and no one knows how space time and matter behaved under these extreme circumstances. Time is not what we believed early, which has no beginning and is endless. We know now that this initial singularity is just the lower limit of time of our universe. Our universe has a beginning. It starts at big bang, about 14 billion years ago. Time also has both lower and upper limits. Time and energy are conjugate partners. When a system reaches the upper energy limit as at big bang, its lifetime will be exceedingly short and the system will explode. If there is no physical process, it is no meaning talking about time.

3.3 Why Will Our Universe Not Expand to Infinity?

It is believed that the big bang resulted in an expansive force which is influenced by dark matter, dark energy, and gravity. These forces have been formalized as the Hubble constant:

$$H_0=v/r=f(d)$$

where d is the density of the universe. From the Hubble constant one can find a critical density d_c. If the density observed of the present universe is smaller than d_c, the universe will expand. Now it is found that the currently estimated d is smaller than d_c. This may be one of the reasons that our universe is expanding. Even though the density of the universe will become smaller, the critical density will also become smaller. If correct, then the universe will expand forever to infinity. Hubble's law is perfectly true in some ways. Our universe is expanding and predictions about the age of our universe are also reasonable. However, as the universe expands all the physical quantities involved, p, r, E and t, will reach their extremes. They should satisfy the limits coupling formulae. None of them can be zero or become infinity. That means that the case needs to be treated by quantized gravity field equations; and this means our universe will have a cyclic structure similar to atomic structure.

3.4 Thermal Energy and Temperature Limits Coupling Formula and Planck Equation

Let us consider some more major physical quantities. The thermal energy of a subject will vary as its temperature changes. In this case, energy increases as temperature rising. We may form a limits coupling formula for this conjugate pair as shown in equation

$$dE/dT = k \qquad (5)$$

where k is Boltzmann constant. For satisfying (5), E and T can also not be zero or infinity. Now, it is a ratio of the limits, instead of product. It is the ratio approaching a universal constant.

$$E_{\max}/T_{\max} \leftrightarrow E_{\min}/T_{\min} \leftrightarrow k \qquad (6)$$

In this case, the limits of the conjugate pair E and T do not complement to each other. It is the ratio varies. When the ratio of E and T reaches a fixed constant and cannot proceed any further, something will happen to reverse the process. For deriving an equation describing how thermal energy changes with temperature, we may directly solve the simple differential equation (5).

Let us consider a free molecular thermal expansion case. Since it is the ratio E/kT varies and the ratio should be considered as the integration variable, x = E/kT. Considering a cooling process, the energy decreases as temperature reaches its lower

$$\int^{x} \left(\frac{dE}{dx}\Big/E\right)dx = \int_{E}^{E_0} \frac{dE}{E} \qquad (7)$$

With the application of a known indefinite integral (Courant, 1937a)

$$\int^{x} y'/y = e^{x}$$

The integration of equation (7) gives

$$e^{x} = \ln E_0/E \qquad (8)$$

(8) may be quantization of thermal dynamic. ln E_0/E can be expanded into a series (Lorenzen, 1971)

$$\ln\xi = \sum_i (-1)^{i-1}(\xi-1)^i, \qquad |\xi-1|<1$$

In our case, $\xi = E_0/E$, When E approaches E_0, we can consider only the first order of the terms $\ln E_0/E = 1 - E_0/E$. Equation (8) gives

$$E = E_0/(e^{E/kT}-1) \qquad (9)$$

Then we obtain a very interesting result. Equation (9) is exactly the same as Planck obtained for average energy per particle at equilibrium, by assuming only discrete energy values or quanta in classical methods of statistical mechanics. (9) works fine under lower limit circumstance. (8) should work under both extreme lower and upper environments for thermal energy and temperature. Equation (8) describes how energy varies with temperature in the whole cyclic process of the gas expansion model of our universe as shown in Fig. 2. From this figure a rough estimation of the lower limit of the thermal energy of our universe is obtained. $E_{min} = 10^{-33}$ ev.

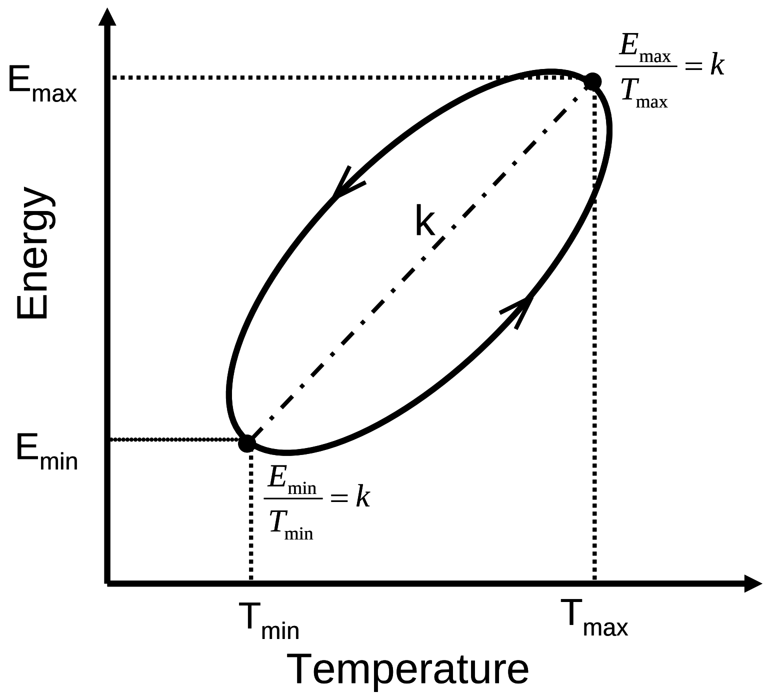

Figure 2.

Once we know the lower limit of energy, from (6) the lower limit of the temperature of the universe will be $T_{min} = 10^{-29}$ ^{0}K. From (2.4) the life time of our universe or t_{max} will be 10^{11} years. As we know that the age of our universe now is about 10^{10} years, so our universe is still young. Of course the estimation from the sketch of the plot is very rough, even the order of magnitude may be questionable.

3.5 Limits Coupling Formulae and Special Relativity Equations

By the theory of relativity, it has been found that physical quantities, length, time and mass will change as their velocity increasing. Famous Lorentz contraction principle, time dilation principle and Einstein equation were discovered.

From the point of view of the principle of limitation and coupling of major physical quantities, any one of these physical quantities and velocity may form a coupling pair, if a limits coupling formula can be constructed for this pair. By solving this formula, it can also show how that physical quantity will change as its velocity.

3.6 Length and Velocity Limits Coupling Formula and Lorentz Contraction Principle

Let us consider that length and velocity form a coupling pair. A length and velocity limits coupling formula may be constructed for *l* and *v* as shown in equation

$$\frac{dlv}{dl} = c \qquad (10)$$

Here lv may be considered as a physical quantity, like p = mv, in a physical process where m does not change. It may be called moment. It is now the ratio of moment and length instead of product of these two physical quantities equal to a constant c. c is the velocity of light which may be considered another universal constant besides h and k. We also tried to obtain some equation describing the variation of length with the changing of velocity from (10) by direct integration

$$v + \frac{dv}{dl} = c \qquad (11)$$

Because it is a ratio, a very simple differential equation appears. Equation (11) can be integrated directly by indefinite integrals.

$$\int v(dl/dv)dv + \int l(dv/dl)dl = \int cdl \qquad (12)$$

This differential equation can be solved by using a known improper integral formula (Courant, 1937b).

$$\int_a^b f(x)\phi(x)dx = \phi(a)\int_a^\xi f(x)dx + \phi(b)\int_\xi^b f(x)dx$$

Let us consider a subject with length l_0 and initial velocity v_i accelerates to a final maximum velocity *c*. During the process, length will change with its velocity and reaches l_f. Applying the integral formula with the initial and final conditions fixed as, for the first integral, $f(x) = v$, $\Phi(x) = dl/dv$, according to our interpretation, $\Phi(a) = l_0/v_i$, $\Phi(b) = l_f/c$ and for the second integral, $f(x) = l$, $\Phi(x) = dv/dl$, $\Phi(a) = v_i/l_0$, $\Phi(b) = c/l_f$. *l* and *v* should have both lower and upper limits. *l* and *v* form a conjugate pair. Their limits must satisfy

$$l_{\max} \bullet v_{\min} = l_{\min} \bullet v_{\max} \qquad (13)$$

In the present case

$$l_f v_i = l_0 c$$

Under this condition, the differential equation will give a result as shown in equation (14)

$$l = l_0(1 - v^2/c^2)^{1/2} \qquad (14)$$

(14) agrees with Lorentz contraction principle exactly.

3.7 Time and Velocity Limits Coupling Formula and Time Dilation Principle

Time and velocity may also form a coupling pair. A similar time and velocity limits coupling formula may be constructed as

$$\frac{ds}{dt} = \frac{dvt}{dt} = c \qquad (15)$$

Another simple differential equation is obtained

$$v + t\, {}^{dv}\!/_{dt} = c \qquad (16)$$

This differential equation (16) is similar to (11). It can be integrated by the same procedures as what we do for (11) and obtain (17).

$$t = t_0 (1 - v^2/c^2)^{1/2} \qquad (17)$$

It is different from the time dilation principle. The discrepancy may because that in its derivation of special relativity, the limitation of physical quantities was not considered. (17) may be considered as quantization of time dilation principle equation.

3.8 Mass and Velocity Limits Coupling Formula and Einstein Equation

Mass and velocity may also form a coupling pair and similar limits coupling formula is composed as shown in (18)

$$\Delta p / \Delta m \to c \qquad (18)$$

Here *p*= *mv*. A simple differential equation will be obtained. Integrating it by similar procedures as above, one gets (19)

$$m = m_0 (1 - v^2/c^2)^{1/2} \qquad (19)$$

This equation is also different from what Einstein derived from relativity.

$$m = \frac{m_0}{(1 - v^2/c^2)^{1/2}} \qquad (20)$$

The equation (19) does also show that velocity cannot be greater than the velocity of light, which has shown in Einstein's relativity theory. However, in (19) as velocity starts from rest and reaches to c, the mass decreases from m_0 to zero, instead of increasing from m_0 to infinity by Einstein equation in (20). Actually, what happens in reality is that the mass disappears when its velocity reaches c. The mass is transformed into radiation. At the end of the process, the total kinetic energy lost will be ${}^{1}\!/_{2} m_0 c^2$. As we know, the kinetic energy has been transferred to radiation. Particle annihilation generally happens in pairs. That gives

$$E = m_o c^2 \qquad (21)$$

It is another Einstein's famous mass and energy exchange formula.

Electron annihilation and pair production of electron with positron by radiation have been observed in the laboratories. Only the rest mass of electron was involved in these mass and energy conversion processes. No indication of raising the mass of electron or energy beyond $m_0 c^2$ was observed.

Tolman in his book of relativity theory (Tolman, 1934) was able to derive from Einstein equation the total kinetic energy of a particle of rest mass m_0 moving with velocity *v*

$$E = \frac{m_0 c^2}{(1 - v^2/c^2)^{1/2}} - m_o c^2 \qquad (22)$$

which reduces as velocity small compared with that of light, to the familiar Newtonian expression $E = {}^{1}\!/_{2} m_0 v^2$ Therefore Einstein equation works fine under ordinary condition as on astrophysics. However, it was not possible to show that as the velocity reaches c, (22) reduced to (21). As pointed out in the book, actually, (21) was not derived but postulated.

Since according to (19) mass decreases with increasing velocity, (22) should be written as (23)

$$E = m_0c^2 - m_0c^2(1-v^2/c^2)^{1/2} \qquad (23)$$

If (19) is used instead of (20) for m as shown in (23), then as the velocity reaches c, (23) does reduce to (21) naturally. As v is small, (23) also reduces to $E = \frac{1}{2} m_0 v^2$. That means (19) works under both ordinary and extreme conditions. It seems that the cause of discrepancy between (19) and (20) might be that in the derivation of (20) the limitation of physical quantities could not be taken into consideration at that time (Ho, 2008). (19) may be considered as quantization of Einstein equation.

3.9 Why Only Lorentz Contraction Principle Agree with the Limits Coupling Formula Result?

Tolman (1934) shows in his book that there are two versions of Lorentz transformation equations. The original version by Lorentz and Fitzgerald gives

$$x = \frac{(x' + vt')}{(1-v^2/c^2)^{1/2}} \quad \text{and} \quad x' = \frac{(x - vt)}{(1-v^2/c^2)^{1/2}}$$

However, in the consideration of the transformation equations for spatial and temporal intervals dx and dx' instead of x and x', also take coincidence into consideration, Lorentz obtained another version

$$dx = dx'(1-v^2/c^2)^{1/2} \quad \text{and} \quad dx' = dx(1-v^2/c^2)^{1/2}$$

By this second version, these two situations are now symmetrical and in entire agreement. In both cases, a stick measures shorter in the ratio $(1-v^2/c^2)^{1/2}$: 1. It is then called Lorentz contraction. The result differs from the contraction originally postulated by Lorentz and Fitzgerald to explain the Michelson-Morley experiment. Since the present result gives a symmetrical relation between two measuring sticks in relative motion. This latter version should also be true for the change of length for a single stick depending on its own velocity. Changing x into dx may mean taking limitation into account. This may be why Lorentz contraction is actually quantized. Einstein equation (20) and equation of time dilation principle were derived from the original version. Had the second version been used in the derivations, (17) and (19) should be obtained.

3.10 Some Evidence that Einstein Equation Needs to be Quantized

Clear evidence can be shown here that Einstein equation cannot be applied as the velocity reaching c. Electron has been accelerated successfully to a speed up to 0.9999999997 of the speed of light by SLAC, Stanford University Linear Accelerator Center. According to Einstein equation, the mass of particle increases with increasing of its velocity. By that high speed, the mass of the electron should have been raised to about hundred thousand times of its rest mass. But such high energy heavy electron has not been observed, instead hard X rays -10 billion times brighter than any X-ray beam on earth has been produced. That is why the Energy Department, their sponsor, wants the lab to have new research missions, including a focus on photon science that deals with the fundamental particles of light and particle astrophysics that explores the riddles of everything from supernovas and black holes to the origin of the universe and also a new name for the lab. As I understand, at that time SLAC was not willing to change the research missions and name.

According to the equation derived from mass velocity limits coupling formula (19), the mass deceases with increasing of velocity. By that high speed, most of the mass has changed into radiation. That is why extremely hard X-rays are observed.

Another evidence can be shown at the big bang. Under the unified theory approach, the elementary particle increases its energy toward the big bang. At big bang the prime particle explored out should have the highest speed. According to Einstein equation, the mass of the prime particle should be nearly infinite. It is believed that the density will be also nearly infinite. The gravity attraction between them should be extremely enormous. They are bounded so tightly. How can they escape and expand? According to the quantized equation (19) the mass decreases with velocity. As the velocity reached its upper limit, the mass becomes almost zero. The prime quanta should be photon. There is no gravity attraction between them. They are emitted out freely. Only after it expands and the velocity decreases, the mass starts to grow. First neutrino, after one micro-second, the quark-gluon plasma forms and the standard hot big bang with inflation model takes over.

3.11 Some Differences Between Special Relativity Equations and Limits Coupling Formulae Results

Even though some results obtained from both the derivations shown above are the same or similar, however the contents of meaning are different. In special relativity it concerns only with how the physical quantities vary with increasing of the velocity. It concludes that l decreases and t and m increase with increasing of velocity. For the equations obtained from limits coupling formulae, it does not only conclude that all the physical quantities must decrease with increasing of velocity, it also requires that the physical quantities must increase as velocity decreasing. All three pairs of physical quantities perform cyclic processes as shown by Figure 3. (14) can be written as

$$\frac{l^2}{l_0^2}+\frac{v^2}{c^2}=1$$

Let us consider the case of the development of our universe. A description of (14) is plotted as shown in Figure 3. It gives an elliptical pattern.

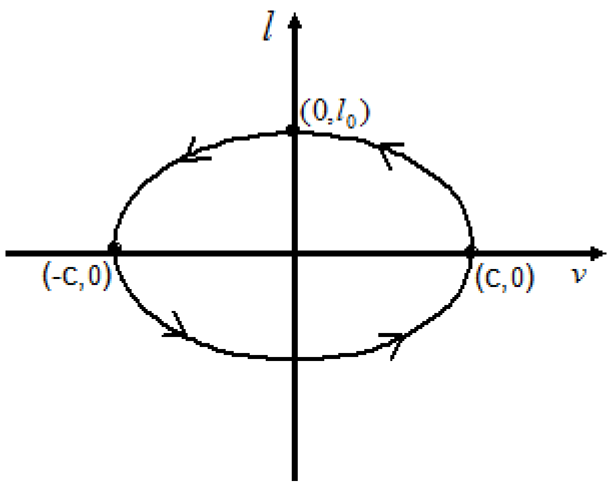

Figure 3.

The patterns of (17) and (19) are similar to (14). Let us start from the beginning of our universe, which is shown at (c, 0) in Figure 3, at the big bang, the velocity of the prime quanta is at its upper limit or the velocity of light. All the physical quantities must be at their lower limits, i.e. length is Compton radius, time is initial singularity and mass zero. As the universe expanses, velocity will decrease and all the physical quantities will increase. This fact has not been revealed in special relativity. Length does not contract and time does not dilate. Both will elongate. Mass will start to appear and grow. First will be neutrino, then different kinds of elementary particles and finally all the materials of nature.

When the velocity reaches its lower limit, the universe will be at its largest size and half life, as shown at (l_0, 0) in Fig. 3. The velocity will then reverse its direction. As it can be seen, negative velocity is allowed in the equations. The expansion of the universe will turn into contraction. In this quadrant of the drawing, the velocity is increasing and this is the case special relativity considered. As velocity reaches its upper limit again, as shown at (-c, 0) in Fig. 3, another big bang will explode. The next new universe will begin.

4. Physical Quantities at Planck Epoch and Limits of Physical Quantities

People have found that many physical quantities can be expressed purely by the universal constants as shown in (24) (Harwit, 1998). They are called physical quantities at Plank epoch.

$$L_p = (hG/c^3)^{1/2} = 1.61 \times 10^{-33} \text{ cm}, \; t_p = (hG/c^5)^{1/2} = 5.38 \times 10^{-44} \text{ sec},$$
$$T_p = (c^2\rho_p/a)^{1/4} \sim 10^{32} \text{ K} \quad m_p = (hc/G) = 2.18 \times 10^{-5} g,$$
$$\rho_p = (c^5/hG^2) \sim 10^{93} \text{ g/cm}^3 \qquad (24)$$

As we know that the limits of physical quantities in the limits coupling formulae are anchored by universal constants. So it is also possible to express the limits of physical quantities purely by universal constants. It is found that the expression of the limits of physical quantities from the limits coupling formula in terms of universal constants are exactly the same as those shown in (24). That means those quantities in (24) are just the limits of the physical quantities of our universe. Except the mass at the big bang, we know the prime quanta are radiation, the mass should be the equivalent mass converted from radiation, or the rest mass at the turning point of our universe. Then we can calculate the energy at Planck epoch $E_p = m_p c^2 = 10^{19}$ Gev. We found $T_{max} = (hc^5/Gk^2)^{1/2} \sim 10^{32}\ {}^0$K.

5. A Naive Quantitative Description of the Development of Our Cyclic Universe

Our universe starts at big bang from a tiny volume of about 10^{-103} m^3. Can you imagine how small the volume is this? Just imagine that our universe now contains a great number of galaxies and each galaxy has billions of stars. All of these grow from such an unimaginably tiny point. The temperature is $10^{32}\ {}^0$K. The prime quanta emitted is photon with energy 10^{19} Gev, or a wave of 10^{43}/sec frequency. As the universe expands, mass starts to grow from neutrino to the other fundamental particles. It will not expand to infinity, but turn back at a turning point. At the turning point we found from the plot that the energy reaches its lower limit 10^{-33} ev and lower limit of temperature at $10^{-29}\ {}^0$K. After this point, the universe will start to contract. The temperature will rise until another big bang. The life time of whole universe cycle is about 10^{11} years.

6. Quantum Cosmology and the Grand Unified Field Theory

Since the discovery of the big bang, early universe has become one of the most interesting subjects of elementary particle physics. People believe that at the big bang of very high temperature, all the classical fields, as weak, electromagnetic and strong fields, as well as string and brane should be unified. Furthermore, according to Einstein equation, mass of the particle increases with its velocity. At big bang the velocity reaches to its upper limits, the mass of the prime particle should be infinite. How can it be emitted out?

According to our quantized Einstein equation, the mass of the particle decreases with its velocity. At big bang the mass of the prime particle is nearly zero. The energy of the universe is now only wave. It is extremely high frequency wave emitted out. Universe is formed of energy. The total energy of the universe is conserved. Energy has dual properties. It has two forms, particle and wave. As the temperature of the universe decreases by expansion, the velocity deceases, wave turns into mass. At first, neutrino and weak field appears, and then electron and electromagnetic field, nucleon and strong field, may be string and brane, atoms, materials,stars, galaxies. As the temperature and velocity reaches the lower limits, the universe is all full with mass, The attraction of gravity will make the universe turning back. Temperature increases. Mass starts changing into wave and reaches another big bang. Some of the waves are within the visible range. Most of the waves are not visible. They are dark energy. It appears that classical fields are created naturally according to the changing of temperature one after another. It seems no grand unification of fields happened.

7. Origins of Quasar and Multi-Universe

7.1 Origin of Quasar

Since 1960 quasar has been discovered, it has been supposed that a most strong radio wave emitted from the source about billions light years away. Its luminosity is several orders more than the brightest galaxies. The mass of the source is about $10^6 – 10^9$ times the mass of the sun. It has a very large red shift, Z > 4. For ordinary Doppler effect and according to the famous Hubble law, the value of red shift is proportional to the distance D of the emitting object.

$$Z = (\lambda - \lambda_0)/\lambda_0 \qquad \lambda_0 = (H_0/c)\, D$$

where H_0 is Hubble constant. For Doppler Effect, $Z \sim v/c$. $v \approx H_0 D$

This shows the relationship of the speed of the star system and the distance. However, for Doppler Effect to cause such a high red- shift, the quasar must have a tremendous speed flying away from the observer. It seems that may not be the case.

The volume of the quasar is very small and the dimension is only about 10^{10} km. Now we still do not know what physical rule can squeeze such an enormous energy into such a small volume (Raychaudhuri, et al., 1992). Thomas Gold of Cornell University constructed a model. He assumed that an extremely dense cluster of stars is formed. Frequent collisions within the cluster give rise to fluctuating emission of light. How can so many cluster stars come so close and collide to each other? It was not known.

Now we may suggest an answer. Our universe may act like a quasar. At the big bang our universe emitted prime quanta with extremely high energy and frequency up to 10^{43} sec. It has enough luminosity, mass and size to be a source of quasar.

A new way causing the red-shift: According to this work, from the quantized Einstein equation (19), as the universe expands, some energy of the prime quanta will change into mass and form elementary particles. The energy or the frequency of the wave will decrease. A red shift appears. The energy changed $hv = m_0c^2 - mc^2 = m_0c^2[1-(1-v^2/c^2)^{1/2}]$.

$$\lambda = h/m_0c\, [1-(1-v^2/c^2)^{1/2}]^{-1} \quad \text{and} \quad \lambda_0 = h/m_0c$$

$$Z+1 = [1 - (1- v^2/c^2)^{1/2}]^{-1} \qquad (25)$$

After many billions of years, the frequency of the wave may decrease to that of radio wave. It is not a most strong radio wave emitted originally. It will be observed in some place of the sky. Then our universe will be recognized as a source of quasar at there. The distance between the quasar and observer will be shortened according to Lorentz principle of contraction as there is a change of speed due to energy decreasing. $D = D_0 (1 - v^2/c^2)^{1/2}$. From this equation and (25), one can get a relation between red shift Z and distance D.

$$Z = D/ (D_0 - D) \qquad (26)$$

When D and Z are small, Z will be proportional directly to D as shown by Hubble’s law. That means Hubble’s law may works for not very far-away star system as on astro-physics even in this kind of red shift process. However, for large Z or very far away quasar on cosmology, (26) may need to be used. Galaxy might also perform a cyclic process. It expands and contracts to a small volume becoming a source of quasar.

7.2 Multi-Universes

There are some speculations about that our universe may not be alone. There may be other universes beside us in the sky. The multi-universe has been an interesting subject discussed in physics and other fields. However most of these works are hypothetical. Many of these theories lack empirical testability and without hard physical evidences. They are outside the methodology of scientific investigation to confirm or disprove. Now we may suggest an observable evidence for the existence of other universe. Our universe can be a quasar. Several thousand quasars have been observed, some of them can be other universes.

From the observational data of these quasars, such as the wave length and the luminosity, one may learn something about the other universes. How far away they are from us. Are they larger or more powerful than our universe. Their life cycles and so on. The sizes of the other universes may be different. Do they have the same physics as ours? Do they have different sets of universal constants? A new field of research opens up to the heaven instead of our universe alone.

8. Conclusion

A group of limits coupling formulae, similar to uncertainty principles, have been derived. By means of these formulae, quantization of most of the classical field equations can be realized. Quantized equations of these fields can be applied in both lower limits environment as in atomic structure, and also in enormous energy environments as at early universe. The coupling of two physical quantities performing cyclic process has also significant meaning. It makes everlasting structures possible in nature. Cyclic process appears to be one of the main processes occurring in both microscopic and macroscopic worlds. From all of these facts, it seems that there may exist a fundamental principle of limitation and coupling of physical quantities in nature. This principle may also provide answers naturally to some long-standing questions such as the origin of quasar and the existence of multiple universes which cycle forever.

Acknowledgment: I thank Flora Tang, my daughter, for her valuable discussion and suggestion in the preparation of this manuscript.

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