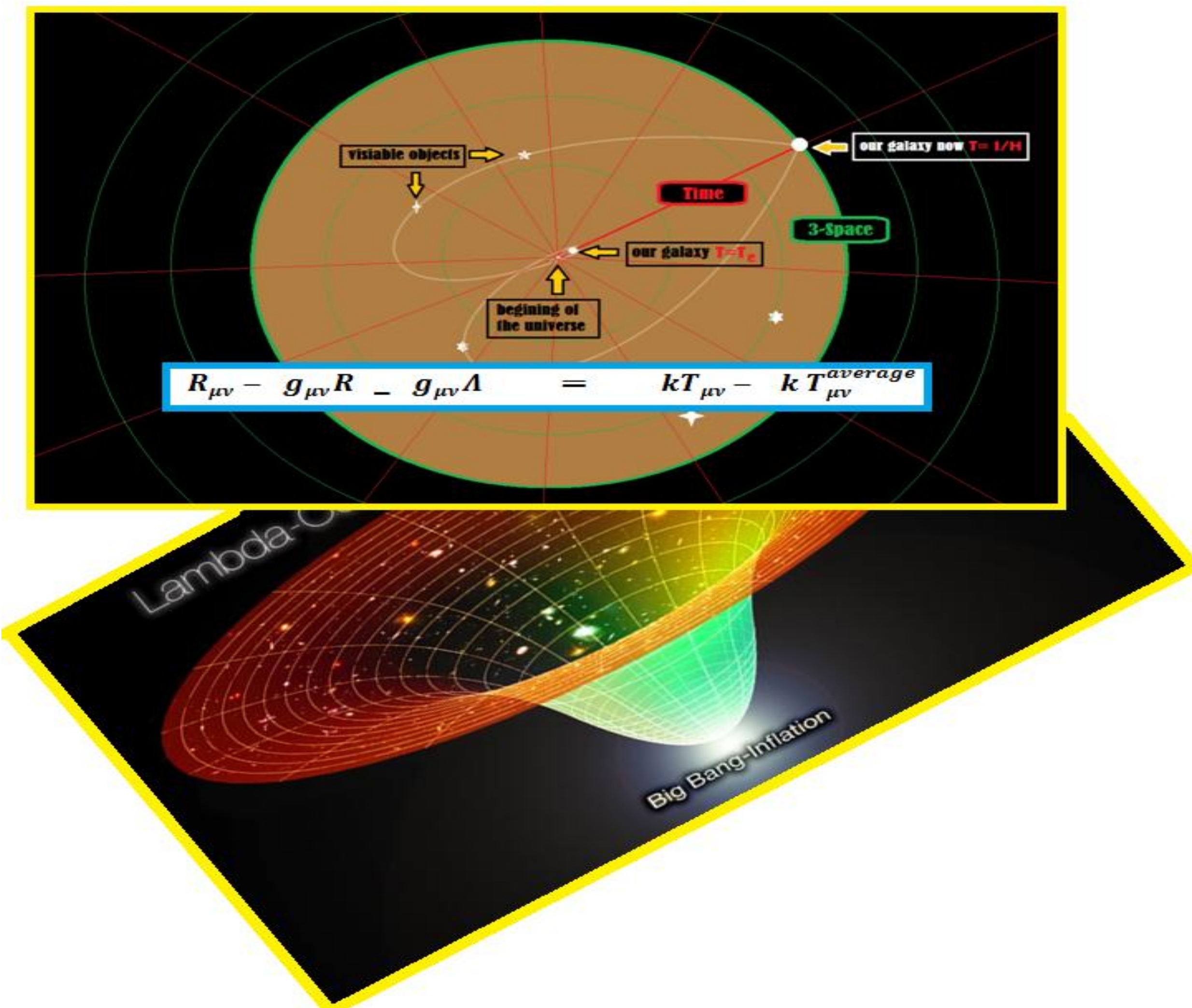
Alternative Cosmological Model without Ad hoc Elements and without Modifications in GR or QM

Mueiz Gafer KamalEldeen

mueizphysics@gmail.com



Abstract

A new simple cosmological model is shown to be able to overcome all major problems of modern cosmology without using ad hoc elements and without any modification in general relativity or quantum mechanics.

Contents

Introduction

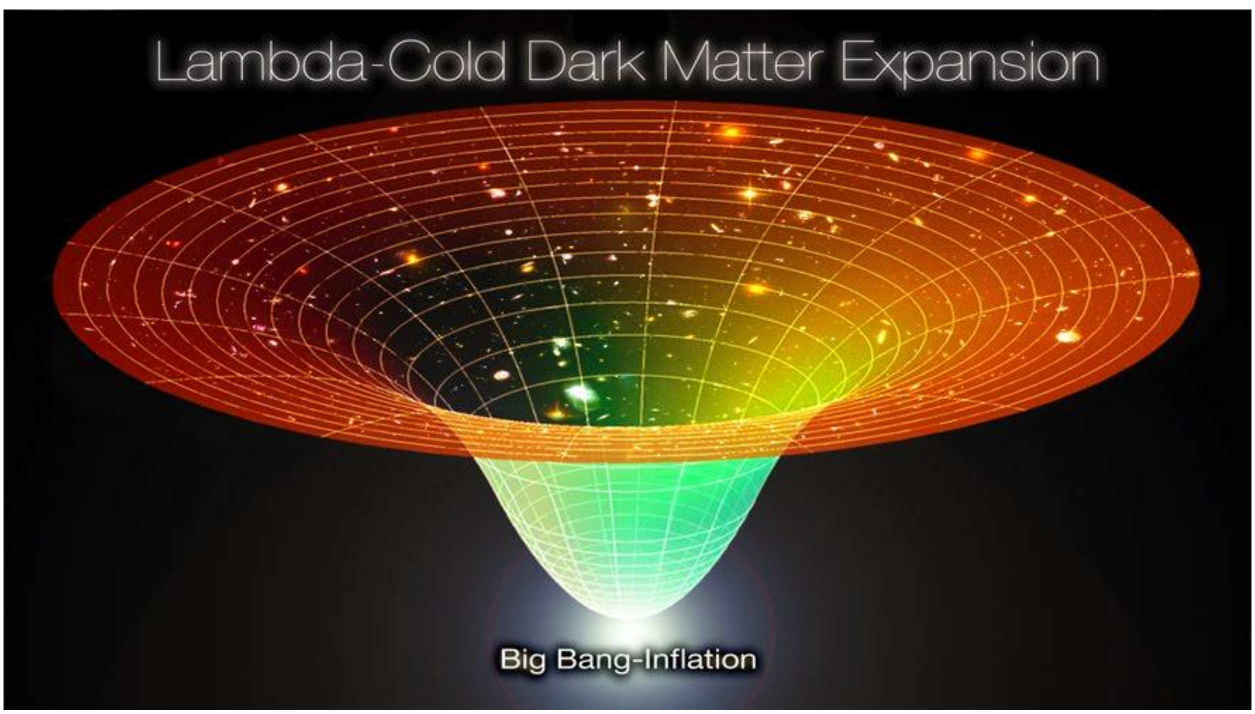
In primitive societies, unseen supernatural beings are cited by people when they are faced with certain natural phenomena which they cannot explain or control instead of taking it as a sign that they need to have the courage to develop a rational foundation so that they can explain why what they see is as it is and why it can never be otherwise.

Indeed, modern cosmologists who support the standard cosmological model are not doing anything different by trying to hide its failure by introducing ad hoc elements without observational support. The great number of the byproducts of this irrational insistence on the standard cosmological model comes at the expense of the search for new ideas.

Our purpose is to introduce a proposed alternative to the standard cosmological model and to show that many of the observations that seem to contradict the standard model seem to support the proposed alternative model.

Summary of the Problems of the Standard Cosmological Model

A Cosmological model is the physical large scale description of geometry and matter content of the universe. The model with the big bang and a cosmological constant which assumes that general relativity is correct on cosmological scales is referred to as the standard model and is claimed by the mainstream physicists to be the simplest model that fits the observations.



There are many problems in the standard model without appropriate solutions. The following are some of these problems:

Cosmological Constant Problem: Disagreement in measured values of the cosmological constant and the zero-point energy.

Horizon Problem: Disagreement in observed anisotropies and the prediction of the big bang theory.

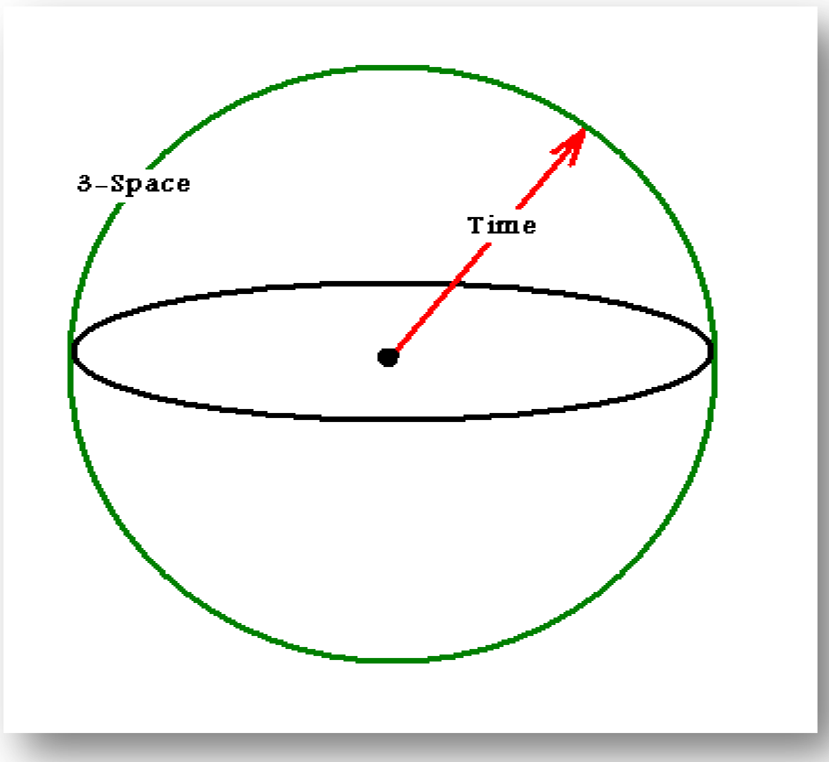
Ecliptic Alignment of CMB Anisotropy: Some features of CMB appear to be aligned with both motion and orientation of the solar system which seems to be unexpected violation of the general Copernican principle.

Galaxy Rotation Curves: Disagreement between the expected and the observed rotation velocities of masses orbiting around galaxies.

In response to these problems and many others, many strange concepts are added (Inflation, Dark Energy, Dark Matter, Multi-verse …) to force the data to fit the standard model.

The Proposed Model

Perhaps, the simplest shape of space-time one can think of is the 4-ball in which the radius represents the cosmological time and the hypersurface (3-sphere) represents our 3-space (x, y, z)



This attractive shape is not far from the imagination of physicists but it is excluded for two reasons:

1) **It seems to contradict the results of the global application of *Einstein's field equation* because according to this model the global geometry of the universe depends only on the age of the universe and has nothing to do with the average density of the universe as (supposed to be) implied by the field equation.**
2) **It contradicts the acceleration of the expansion of the universe which is (supposed to be) supported by the observational data the cosmological**

red-shifts, because a model of a spherical space with radial time implies a steady expansion of the universe.

Instead of hurriedly excluding this shape of space-time, our proposed cosmological model tries to overcome these difficulties.

We can overcome the first difficulty easily by adopting a good definition for the cosmological constant which eliminates the dependence of the global geometry of the universe on its average density and relates it directly to the age of the universe. The cosmological constant which satisfies these requirements is the quantity that composed of two parts: the geometrical part which is the curvature of the universe determined by the age of the universe and the material part which is the average density of the universe .This proposed definition of the cosmological constant will not only enable us to use the simple model of radial time and spherical space but will also solve all the problems of modern cosmology which are generated from the dependence of the global geometry of the universe on its density like the *Cosmological Constant Problem* without ad hoc elements (dark energy, inflation, multi-verse, extra dimensions … etc.).

Now we can rewrite the field equation of general relativity:

$$G_{\mu\nu} - \left(G_{\mu\nu}^{global} - k\, T_{\mu\nu}^{average(global)} \right) = k\, T_{\mu\nu}$$

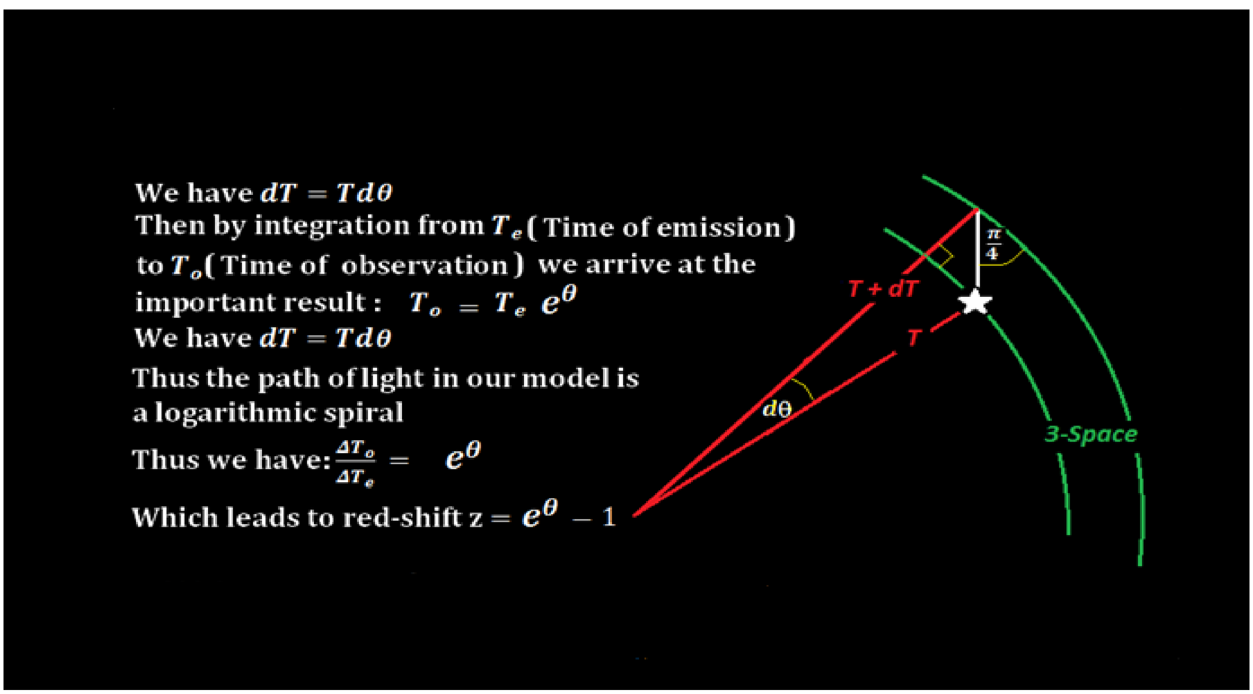
This can be written in a more beautiful form as a relation between the differences between local and global quantities in both sides of the equation:

$$G_{\mu\nu} - G_{\mu\nu}^{global} = k\, T_{\mu\nu} - k\, T_{\mu\nu}^{global}$$

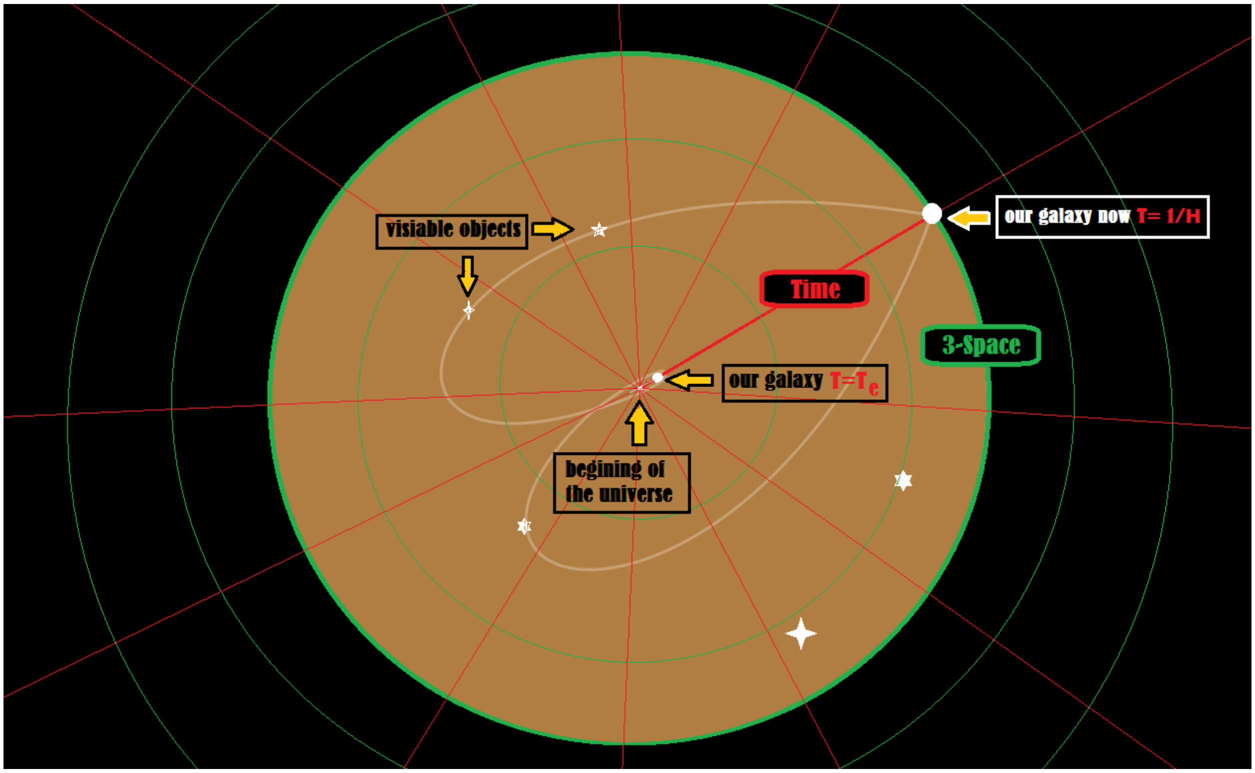
This will not affect the successful local application of the field equation because of the small value of the average density compared to the density of the source of the gravitation field (the zero-point vacuum energy density is canceled out because it is a part of both the cosmological constant and the stress-energy tensor)

Now, let us turn to the second difficulty with our proposed model of the accelerating expansion of the universe or more precisely the cosmological red-shift which is assumed to be a result of the acceleration of the expansion. Surprisingly, our simple spherical model which denies this acceleration offers another interpretation of this cosmological red-shift. It can be proved mathematically by analyzing the world-line of light as it travels through this shape of space-time between the source and the observer that it is a logarithmic spiral which leads to a red-shift given by: $z = e^{\theta} - 1$

Let us define the path taken by light when it travels between a source and observer in our proposed model. Because of the symmetrical properties obtained from the spherical shape of space-time in this model, the path can be analyzed in two-dimensional diagram with less effort than that required when using four-dimensional differential geometry. The equation of this path can easily be derived using the constraint condition that the path of light must intersect the 3-space which is represented by circles in the two-dimensional diagram) locally at an angle $\tan^{-1}$ C (speed of light) which is equal to $\frac{\pi}{4}$ (in the system of units where C = 1)



This agrees with the observational data as will be shown later and reproduces Hubble's Law in small values of θ .

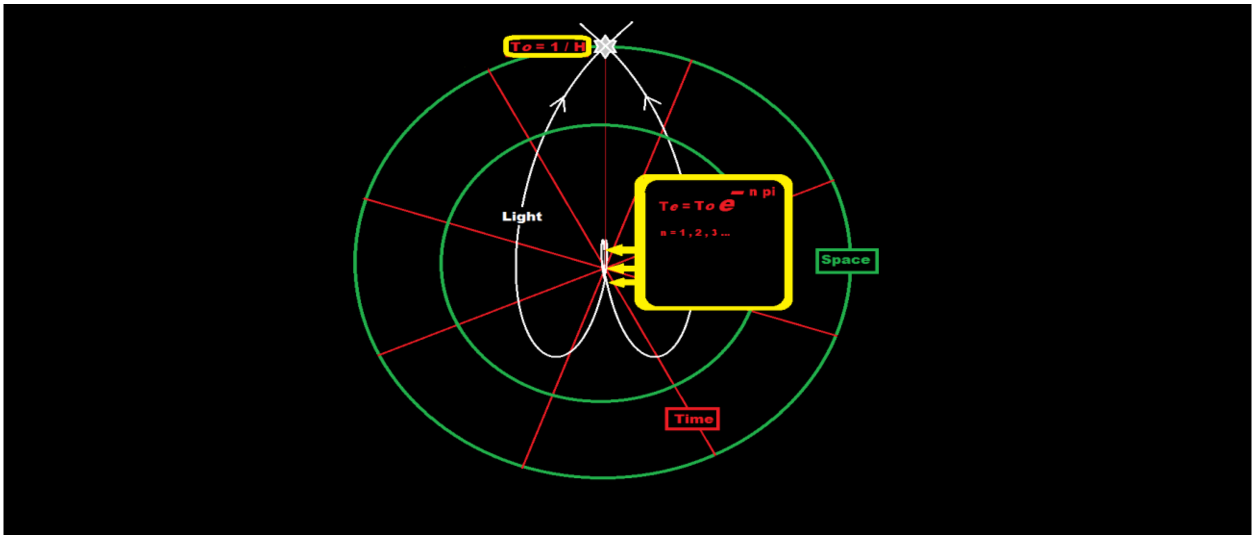


Resolutions of Problems of Modern Cosmology

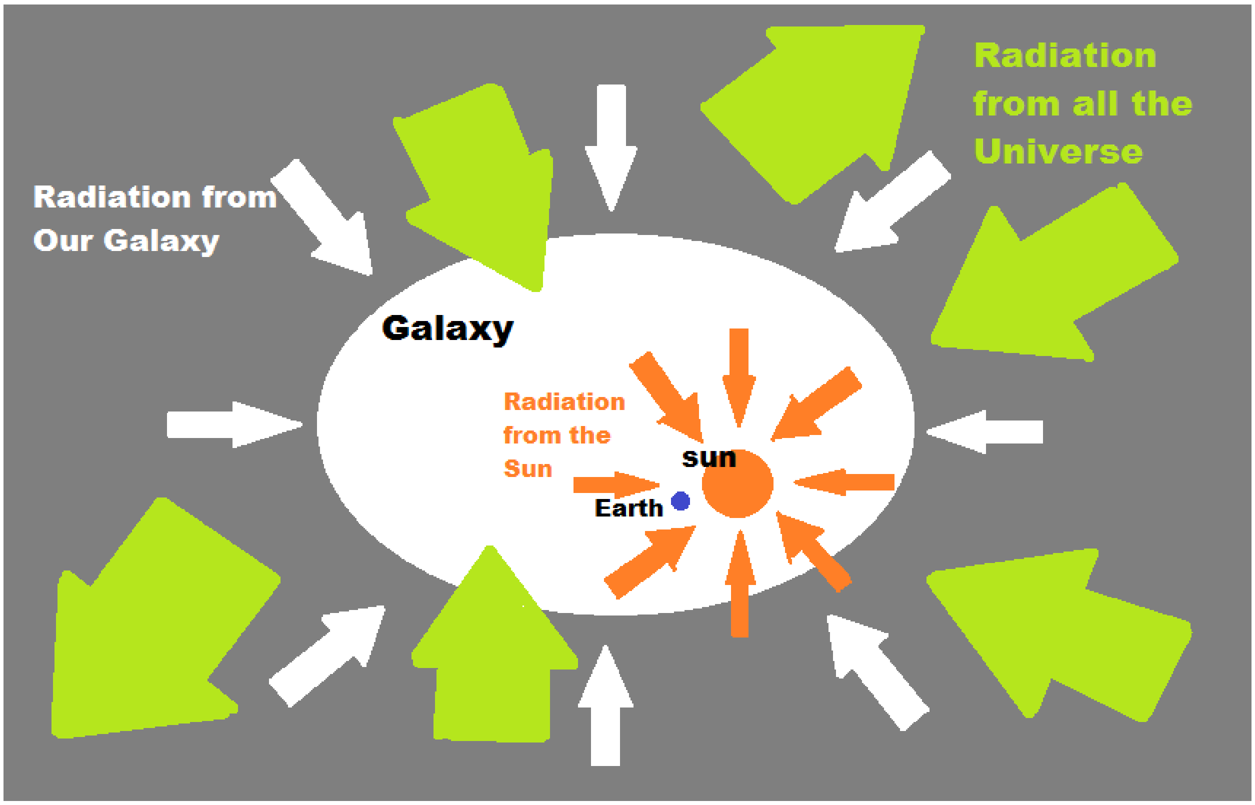
It will now be of interest to show how this proposed model can solve major problem of modern cosmology very nicely.

Cosmological Constant Problem and Flatness Problem: The significant feature of our proposed model that geometry of the universe is dependent on the age of the universe alone(which is resulted from canceling out of all energy which is distributed homogenously in the universe as a result of the existence of the average stress energy tensor as a part of the cosmological constant)will directly eliminate all the problems of cosmology that associated with the dependence of the global geometry of the universe on its average density like the cosmological constant problem and flatness problem.

Horizon Problem and the Ecliptic Alignment of CMB Anisotropy: According to the above equation of the world line of light: $T_o =: T_e \; e^{\theta}$, all the radiations emitted from a source whose world line is at angle $n\pi$ with our world line (this includes radiations emitted from our own galaxy and radiations from all universe at early stages) reach us at time : $T_o = T_e \; e^{n\pi}$, from all directions. This provides us with a simple definition for cosmic background radiations.



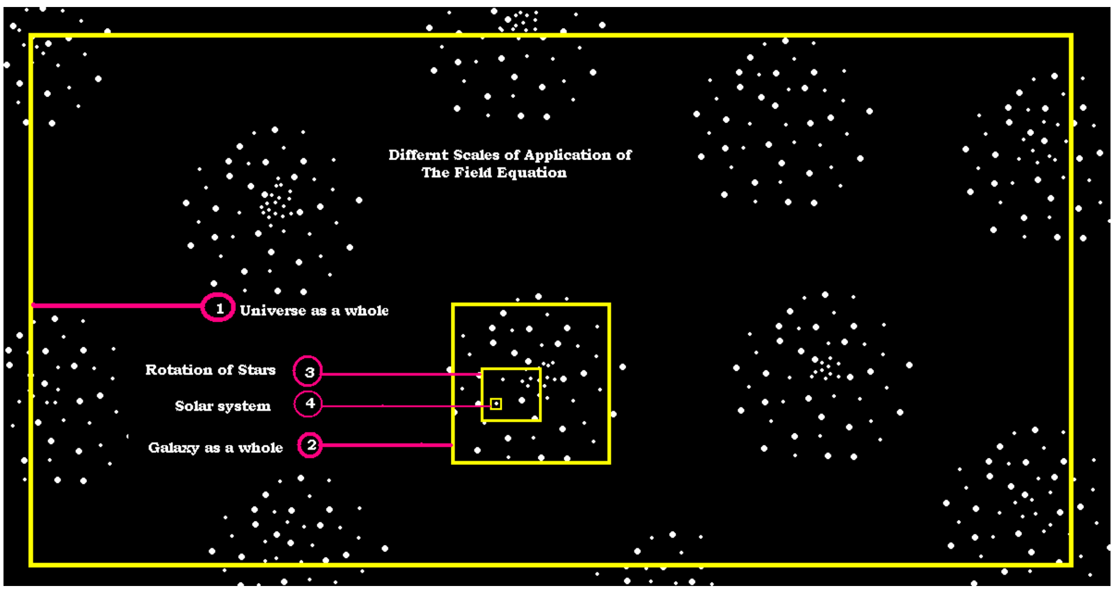
This may also offer an answer to the problematic phenomena which was discovered recently that some features of the cosmic radiation is aligned with the orientation of our solar system which can be thought of as the part of radiation which is emitted from the sun then converged to reach it again from all directions and thus appears as aligned with the ecliptic plane for any observer near the sun.



There is indeed so much in these topics which such an approach cannot but miss.

Galaxy Rotation Curves: Because the universe is not perfectly homogenous, some of its features may manifest themselves in certain scales and disappear in others, so if we assume that the cosmological constant is affected by the distribution of the energy around the region of the application of the field equation then it seems unreasonable to insist to use the same cosmological constant in different scales of application. For example : in the scale of our solar system , other stars in our galaxy and other galaxies in outer space is not expected at all to have any significant effect on the geometry or anything else in this scale because of the great ratio between the average distance between

the stars and the distances in our solar system which makes it practical to assume an empty background and neglect the existence of objects other than the sun, not like the case of the application of the equation to make calculation about the rotation of a star around the galactic center where all other stars in the galaxy appear as clear background for a region with this size or the application of the equation in the galaxy as a whole where the background density of the universe is taken into consideration because the average size of the galaxy is comparable to the average distance between galaxies. The value of background density of matter which appear as distributed around the region that we choose to apply the field equation in it, differs according to the scale of the application of the equation because certain parts of the matter in the universe is taken into consideration or be neglected according to this scale.



Now we can see how the background density of space is changed according to the scale and how this can solve the problems of cosmology using the assumption (or the approximation) that the matter is distributed homogenously in the background in each case:

1) Global Application: Here the background energy density is the average density of the universe itself and thus the right-hand side of the equation is equal to zero and the global geometry of the universe is independent from its density:

$$G_{\mu\nu}^{universe} = g_{\mu\nu}\Lambda = \text{const} / T^2$$

2) Application of the Equation in a Galaxy as a Whole: If we assume a homogenous distribution of matter in the galaxy then the background energy density is the average density of the universe and the equation is:

$$G_{\mu\nu}^{galaxy} - G_{\mu\nu}^{universe} = k\,T_{\mu\nu}^{galaxy} - k\,T_{\mu\nu}^{universe}$$

3) Application of the Equation in the Scale of the stellar systems (like the application of the equation in our solar system) : In this scale the density of the galaxy and the density of the universe are very small compared to the density of the star so the star appears as located in empty universe.

$$G_{\mu\nu}^{near\ or\ inside\ star} - G_{\mu\nu}^{universe} = k\,T_{\mu\nu}^{near\ (T_{\mu\nu}=0)\ or\ inside\ star}$$

4) Application of the Equation in the Space in the Scale of the Movement of the Stars inside the Galaxy: Here the background density of the space is the density of the galaxy and the density of the universe is negligible compared to the density of the galaxy.

$$G_{\mu\nu}^{empty\ space} - G_{\mu\nu}^{universe} = k\,T_{\mu\nu}^{empty\ space} - k\,T_{\mu\nu}^{galaxy} = -\,k\,T_{\mu\nu}^{galaxy}$$

This property of space shown in the last case of being equivalent to having negative density which appears in this scale may be thought of as what is interpreted as *Dark Matter* in the standard model, that is because according to the field equation, when an astronomical object is found in such a space its geometrical (gravitational) affects will increase (more than its effect if it were embedded in a space of zero or positive density).The source of the gravitational field (group of stars in the center of the galaxy) and the gravitating object (a star) appear as having more than their real masses because of the negative background density which appears in this level of application of the field equation. This also explains why we can only detect (what is interpreted as) dark matter in the scale of the rotation of stars inside the galaxy but not in local observation near the stars (such as our solar system).This is only the general idea and surely further analysis is necessary to establish an accurate relations.

Theoretical Evidences for the Independence of the Global Geometry of the Universe from its Average Density

Here we shall be concerned with some theoretical considerations which may be considered enough to justify looking around for possible ways out of the standard cosmological model and which indicate that the validity of the basic assumptions and results of our proposed cosmological model can be emphasized more directly than by its success as a description of cosmological phenomena.

The Scale Problem: As we have seen in the previous section, the dependence of the global geometry of the universe on its average density is the main source of the problems of the standard model .Now; I am advancing by a thought experiment an argument that this dependence is not only problematic but also paradoxical:

Let there be a universe with critical density (density parameter Ω = 1).And, let there be a powerful designer who want to create a small prototype of this universe (in the same way as those models made by engineers in small size for their structures which is subjected to complex flow phenomena for which mathematical analysis is not available to avoid financial and safety risks of the experiments on the structures in their real size.).

It can be seen now that the requirements of general geometrical and dynamical similarities which imply that all intensive quantities such as the density must be the same in the real universe and the prototype , contradict the requirement that the prototype density is critical , because according to the equations of the standard model , the critical density depends on Hubble's distance which is different between the real universe and the prototype as required by geometrical similarity. This is a very remarkable result. It tells us that there must be some error in our equations.

This argument holds independently of the details of the microscopic structure of the universe because the size of the prototype can be made so large to isolate any doubts about different behavior of different sizes of similar universes due to the elementary structure of matter .So to allow for this prototype to work, we must make some radical changes in our equations.

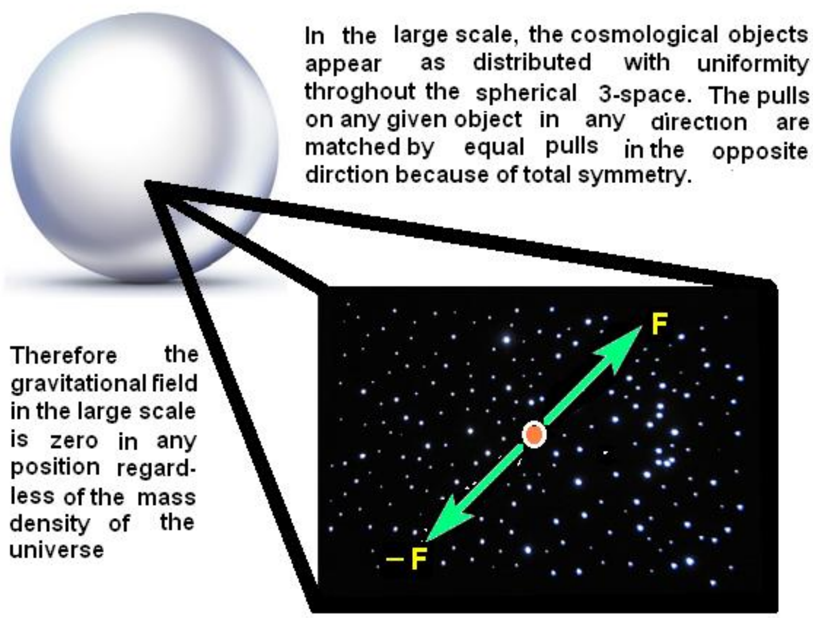
Newtonian Approximation: Newton's law of gravity was replaced by General Relativity for both theoretical and observational reasons and in spite of being essentially different from General Relativity, Newton's law of gravity can be recovered from the field equation of General Relativity as an approximation in special cases, this fact played an important role during the construction of the field equation. What I am going to put in front of the reader is another major role for this fact.

According to the standard modern cosmology, there are three possibilities of the shape or the large-scale geometry of our universe but whatever is the real shape of the universe, the field equation of General Relativity should be applicable and correct in all these possibility.

Let us fist pay our attention to the fact that every case in Newton's Gravity can be proved with General Relativity.

Now when we consider the possibly of spherical shape of the universe in which the matter is uniformly and homogenously distributed throughout the space as appears in the large scale (our argument will not be affected even if this is not a precise description of our universe because General Relativity and Newtonian Approximation is applicable and correct also in the ideal case and all three possibilities) we will find according to Newton's law of gravity that the value of the gravitational field in any region of such a space must be zero because of the total symmetry and similarity of all directions (there is no preferable direction for a gravitational force that could act on an object) so we arrive at the important fact that in this case the gravitational field is zero regardless of the value of the density of matter in the universe . But can this be explained by General Relativity? In General Relativity, as we are always told, the existence of matter must be associated with the geometrical deformation of space that causes gravitational effects? Is it a contradiction?

This conflict between general theory of relativity and its Newtonian Approximation cannot be resolved except if we abandon the unnecessary and unjustified assumption that the large scale geometry of the universe should depend on the average density simply by assuming that this average density of the universe is a part of the cosmological constant and therefore the large-scale geometry of the universe well not be affected by this density while the local application of the field equation ,in which deviations from uniformity come to light, remains with its well-known successful results .



The Dependence of the Global Geometry of the Universe on its Average Density is a Wrong Generalization: Before considering the following thought experiment, it should be highly emphasized that it is intended only , by using the more familiar behavior of a creature exploring the surface of a balloon ,to show that we are subjected to fall back on certain kind of unjustified

presumption when we generalize any kind of field equations to a universe of total homogeneity ,without any claims of similarities between the properties of space -time and the elastic balloon.

Suppose that a balloon inhabited by a creature (not necessary two-dimensional) who want to study the theories of elasticity on his universe in the large scale. It is not a very good balloon, in that it has different values of elasticity factor across the surface in a way analogous to the distribution of mass and energy in our universe. After covering enough area of his universe, the creature can find the relation between the elasticity factor and the curvature of the surface of the balloon to be in the following form: (curvature = E + A).Where (E) is a quantity that depends on the local elasticity factor , and (A) is another constant cosmological quantity not known to him however we know that it is a simple function of the radius of his spherical balloon .

Now when this creature want to apply his equation in his large-scale universe he may assume total homogeneity of elasticity across the surface of the balloon and by generalizing his relation between elasticity and the curvature of the balloon , his calculation will surely lead him to a global relation between the average elasticity and the global curvature of his universe(although we know that this is not correct ,because the global curvature of the balloon depends only on the radius of the balloon and has nothing to do with the average value of elasticity factors).

Then he can also make additional calculations concerning the stability and he will surprisingly enough , taking into account the observations confirming the stability of his universe , find that the value of the average elasticity of his universe must be precisely equal to the critical value needed to this stability (which is also incorrect result because the balloon is stable regardless of the average elasticity).

Then some other inhabitants of the balloon will become a bit worried about explanation of this fact by saying '' that is just the way it was '' and to overcome this difficulty they may add other complications by making some speculation about the initial process of filling the balloon with the fluid , without turning their attention to the validity of their unjustified

generalization of their equation which relate the elasticity factor and curvature .

Now , considering the application of Einstein's Field Equation in total homogenous universe, to avoid a similar mistake we must try the possibility that the relation between the curvature of space-time and the stress-energy tensor cannot be generalized to the universe of total similarity in all its parts , and that the global curvature depends only on the age of the universe and has nothing to do with the average density and thus the concept of critical density becomes meaningless and the large-scale shape of the universe is no longer dependent on its material content .We will lose nothing by adopting this possibility because the global curvature of the universe is obtained simply from the age of the universe and Einstein's Field Equation can be applied in any part of the universe while the current flatness of the universe is a natural consequence of its old age .

The Meaning of the Cosmological Constant and the Field Equations: If we begin with Einstein's famous statement:" ***it is the theory which decides what can be observed*** **'' then the zero-point vacuum energy would be a meeting point for Quantum Mechanics and General Relativity only if we make sure that this quantity is observable in general relativity and if it is not observable we will show why we should not expect it to be related to the space-time curvature.**

The zero-point energy of a system and its statistical result that the empty space has a non-zero ground state or lower energy density are direct and unavoidable results of quantum physics but the analysis of the detection of this ground energy density of vacuum by experiment shows that we can only measure the deviation from this energy density rather than its absolute value.

This " undetectability" of the zero-point vacuum energy density is not equivalent to non-existence in quantum physics because in quantum level we deal with systems which are not statistical where higher or lower levels of energy are probable and situations in which some of this energy is excluded

from certain regions like the experiment known as Casmir Effect. But in the cosmological scale of general relativity the quantum zero-point vacuum energy is only a homogenous density that permeates all the space and there are no such differences to make it detectable.

To relate this undetectable quantity to a detectable geometrical quantity would be a violation to the most important of the fundamentals of general relativity which is summarized in Einstein's famous quote : '' *Space-time and gravitation have no separate existence from matter* '' which he said when forced to summarize the general theory of relativity in one sentence. This statement is not a general or abstract philosophy but rather a very effective tool which led him to the field equation because it implies that tall the properties of matter must be found in the geometrical quantity which is related to it: this can be shown if we consider the reason for the selection of the quantity ($R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R$) to represent the geometrical side of the field equation from other unlimited number of other possible geometrical quantities (such as : $R_{\mu\nu} + gR_{\mu\nu}$, $g_{\mu\nu}R$, $RR_{\mu\nu}$, $g_{\mu\nu}R$ ... etc.) which is that the quantity ($R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R$) have the Biancirelation which tells us that : ($R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R$);v = 0 and thus a geometrical relation corresponding to the mass-energy conservation is gained. This means that our selection of the geometrical side of the field equation is based on the important assumption that all the properties of the material side must find a corresponding in the geometrical side,in other word, geometry and matter must be like two different languages that describe the same reality so we cannot for example select the quantity ($g\ g_{\mu\nu}R$) to be the geometrical side of the field equation and think that it is enough to think of a relation ($gg_{\mu\nu}R$);v = 0 as a result of the relation between matter and geometry without pure geometrical poof.

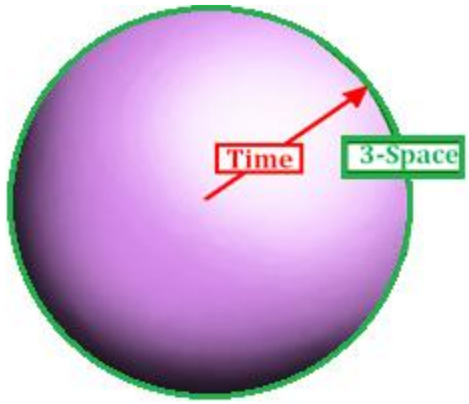
The assumption that in the absence of matter in the space-time the geometry is flat is not the best one because it is assumed to be based on the principle of simplicity while it can be seen that the flat space-time is more complex than a spherical 3-space with radial time (SSRT.) for many reasons such as:

1) **Flatness involves arbitrary direction when embedded in another space.**
2) **SSRT. is symmetric while flat space is only symmetric if it is infinite.**

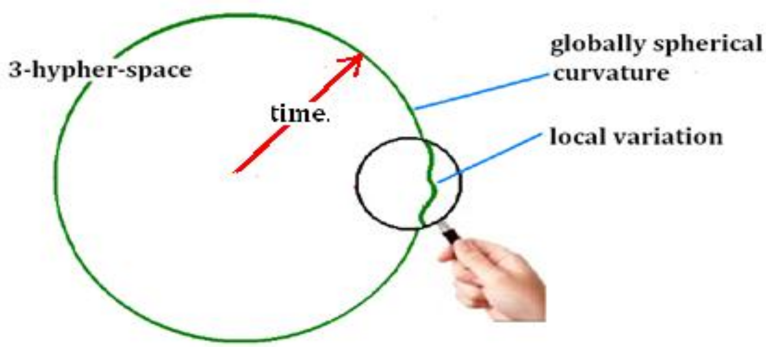
3) **In the SSRT. the passing of time and the expansion of the space may be seen as the same phenomenon.**

In addition to other advantages of SSRT:

4) **In SSRT the special nature of time is revealed.**
5) **In SSRT there is a meaning of the beginning of time.**



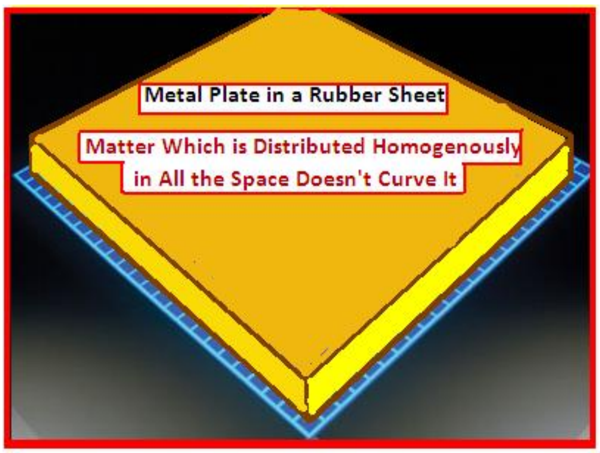
Then if we adopt the spherical space with radial time we have in the absence of matter a non-zero value for the curvature of space which depends only in the age of the universe.

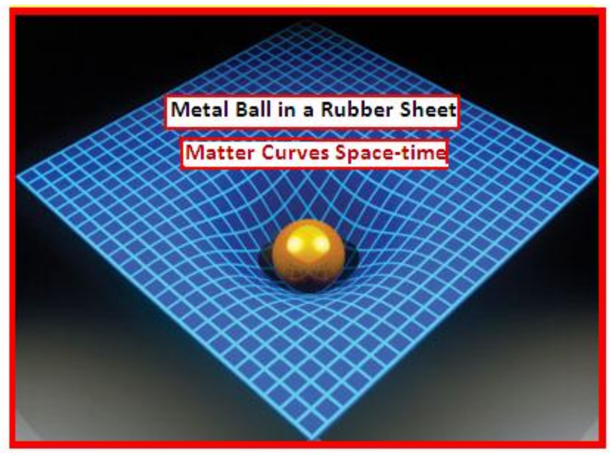


The field equation of general relativity will then be expressible as a relation between deviation of matter from the universal ground state (not only the quantum zero-point vacuum energy but all density of energy which is distributed homogenously in the universe) and the deviation of the geometry from global curvature:

$R_{\mu\nu} - g_{\mu\nu}R - g_{\mu\nu}\Lambda$	$=$	$kT_{\mu\nu} - k\,T_{\mu\nu}^{average}$
Deviation from the geometrical ground state	$=$	**Deviation from the material ground state**

So all undetectable quantities is excluded from the field equation of general relativity because the zero-point energy density of vacuum or any other density which permeates all the space will not have any role in this equation because its contribution in ($kT_{\mu\nu}$) is canceled out by its contribution in ($k\,T_{\mu\nu}^{average}$).





This of course makes our proposed model much simpler than the standard model:

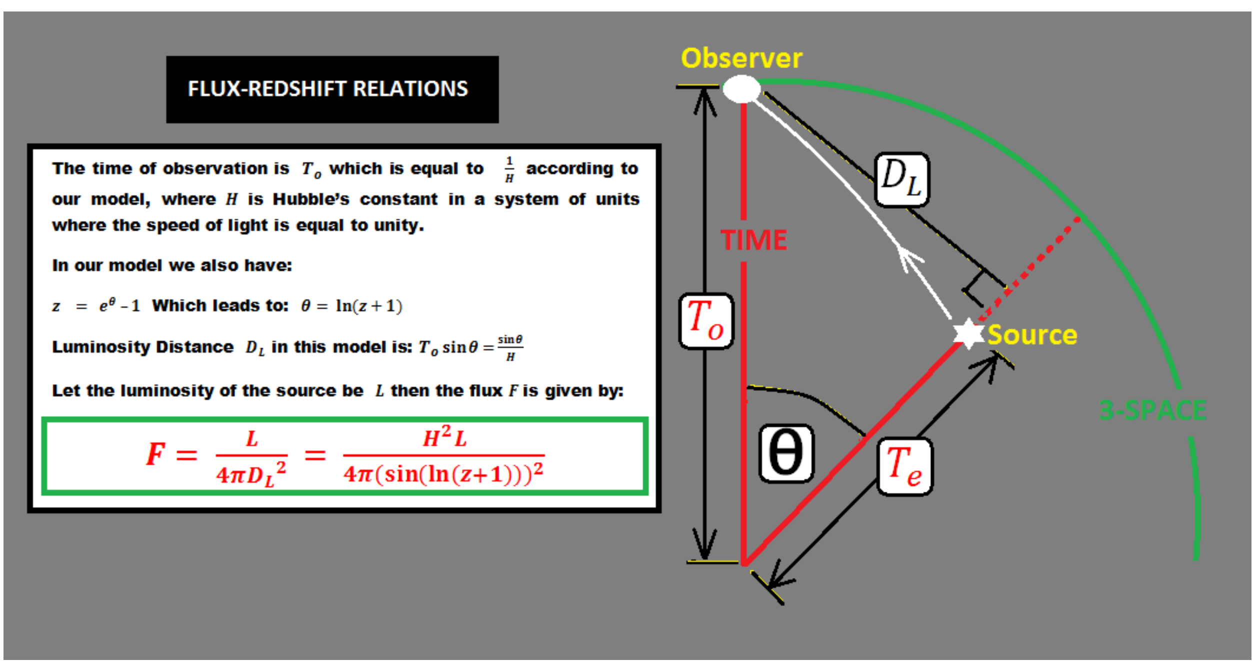
Standard Model	Propoesd Model
Friedmann equations $$\frac{\dot{a}^2 + kc^2}{a^2} = \frac{8\pi G\rho + \Lambda c^2}{3}$$ $$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}\left(\rho + \frac{3p}{c^2}\right) + \frac{\Lambda c^2}{3}$$	The Volume of the universe $\propto$ T^3 Hubble's Constant $\propto$ $\frac{1}{T}$ The Cosmological Constant $\propto$ $\frac{1}{T^2}$ Where T is the age of the universe

Observational Test of the Alternative Cosmological Model

The plan of this test is to identify some of the relations between physical properties obtained from this cosmological model which distinguish it from the *Standard Cosmological Model* and other existing models and compare these relations with the model-independent observational data.

One of the best of these relations is the Redshift-Flux relation because both redshift and flux are model-independent physical quantities and fortunately some natural phenomena such as *type la supernova* provides us with the tools needed to construct the relation between these two quantities in different cosmological models because this type of supernova gives a certain known amount of light and thus represents a standard candle that can be used to calculate luminosity distance which can be used to link the flux to the red-shift according to the adopted cosmological model.

Now, let us see the mathematical form of this relation in our proposed cosmological model:



This is an extremely interesting result, connecting as it does the luminosity distance and red-shift. The two quantities are independently measureable so that the relation provides a good test of the success of the model. Actually, there is a good agreement between this relation and the observational data. The following table is a sample to show the nature of this agreement.

SN	Z(assumed precisely accurate)	μ(Distance Module)	Associated Error of μ	Quality
SN900	0.030	35.90	0.20	**Gold**
SN90T	0.040	36.38	0.21	**Gold**
SN9af	0.050	36.84	0.22	**Gold**

This is enough for this highly compressed treatment, for more data the reader is refereed to: Riess et al. 2007

Conclusion

In any case, in the previous sections we were led to the fact that the assumption of dependence of the global geometry of the universe on its average density is unnecessary and undesirable. And it was my plan to consider the significant results of this fact in simplifying our model of the universe and canceling out its problems.

In concluding, I wish the reader will confine his investigation about this proposed model to objective criteria far from the influence of social dynamics of the vast majority of the conformists of the standard theories which has no meaning from the standpoint of scientific method.