QUADRONOMETRY AS A DEFINING TOOL FOR COSMOLOGICAL CONSTANT UNIT IN EINSTEIN FIELD EQUATIONS

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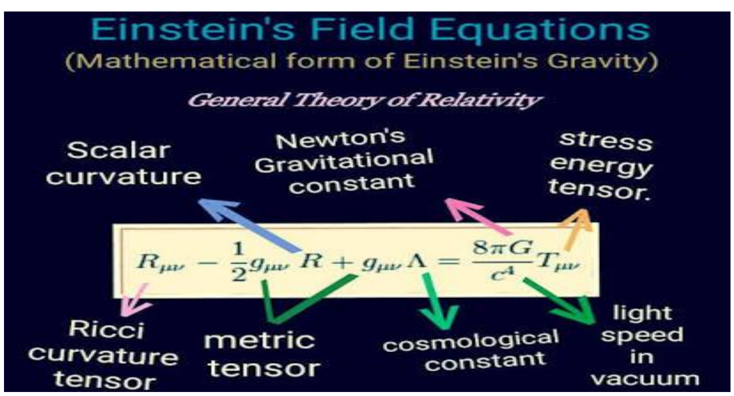
ABSTRACT

General relativity is a theory of gravitation developed by Albert Einstein. The development of general relativity began with the equivalence principle, under which states of accelerated motion and being at rest in a gravitational field (for example, when standing on the surface of the earth) are physically identical. The upshot of this is that free fall is inertial motion: an object in free fall is falling because that is how objects move when there is no force being exerted on them, instead of this being due to the force of gravity as is the case in classical mechanics. This is incompatible with classical mechanics and special relativity because in those theories inertial moving objects cannot accelerate with respect with to each other, but objects in free fall do so. To resolve this difficulty Einstein first proposed that spacetime is curved. In 1915, he devised the Einstein Field Equations which relate the curvature of spacetime with mass, energy and any momentum within it.

Technically, the Einstein Field Equations is a defining tool for the theory of gravitation, namely the General Relativity. The solution of the field equations are the metric tensors which define the topology of the spacetime and how objects move in inertial motion. But, there was a greatest blunder in the equation of Einstein Field Equations, the term "cosmological constant" was found in the said equation. According to Einstein, cosmological constant term allows for a universe that is not expanding or contracting. This effort was unsuccessful because the universe is expanding through Hubble's observations. To resolve on this questionable nature of cosmological constant, my proposal is to make it an arbitrary constant based on the solved formula from my Quadronometry.



CONTENT AND RATIONALE

General relativity explains the law of gravitation and its relation to other forces of nature. It applies the cosmological and astrophysical realm, including astronomy. However, it did not appear to be useful, beyond making minor corrections to predictions of Newtonian gravitation theory. It seemed to offer little potential for experimental test, as most of its assertions were on an astronomical scale. Its mathematics seemed difficult and fully understandable only by a small number of people. Around 1960, general relativity became central to physics and astronomy. New mathematical techniques to apply to general relativity streamlined calculations and made its concepts more easily visualized. Some astronomical phenomena were discovered, such as quasars (1963), the 3 – kelvin microwave background radiation (1965), pulsars (1967), and the first black hole candidates (1981), the general theory of relativity explained their attributes, and measurement of them further confirmed the theory.

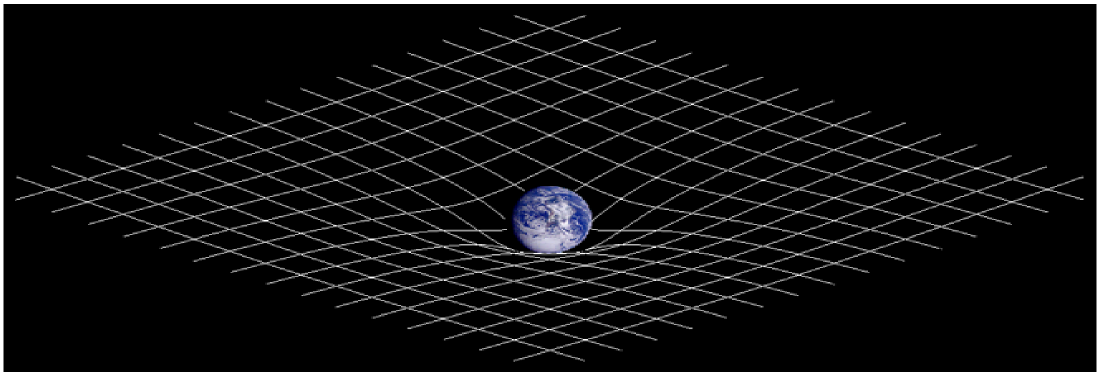
General relativity has also been confirmed many times, the classical experiments being the perihelion precession of mercury's orbit, the deflection of light by the Sun, and the gravitational redshift of light. Other tests confirmed the equivalence principle and frame – dragging.

Einstein stated that the theory of relativity belongs to a class of "principle – theories". As such, it employs an analytic method, which means that the elements of this theory are not based on hypothesis but on empirical discovery. By observing natural processes, we understand their general characteristics, devise mathematical models (as such, my Quadronometry will attempt to be useful application) to describe what we observed, and by analytical means we deduce the necessary conditions that have to be satisfied. Measurement of separate events must satisfy these conditions and match the theory's conclusions.

For an instance, one of the consequences of general relativity is the Universe expansion, wherein the expansion of universe is never – ending, and far parts of it are moving away from us faster than the speed of light. In this consequence, we tend to apply the Einstein Field Equation but earlier in the abstract of this research, there was a greatest blunder due to the concept application of cosmological constant, which pertains to finite set of universe expansion. To resolve on this matter, this action research aims to apply one of the equations made by the researcher based on his mathematical invention known as Quadronometry.

Quadronometry is a mathematics of replication of four – sided figures. And since we knew that the spacetime curvature is warped – like made up of four – sided figures, it is my call to use one of my equations in helping the cosmological constant be well – defined.

CONCEPTUAL AND THEORETICAL FRAMEWORK



STATEMENT OF THE PROBLEM

The earth with some neighborhood matters in space, for example, can define its quadronometric designs collectively by a formula Cosmological Constant(Λ)= $\frac{n^2(n-1)^2}{4}$

Where n = the number of matters in space.

Cosmological Constant is arbitrarily defined by the number of quadronometric designs known as squad designs. The equation was based from inductive reasoning or finding the pattern from the number of squad designs as the number of ranks/no. matters progressively existing.

The action research aims to answer the following questions through documentary or literature review analysis and theoretical propositions:

1. What do we mean by Quadronometry?
2. Why we need Quadronometry in defining the cosmological constant?
3. How do we apply Quadronometry in defining the cosmological constant of Einstein Field Equations?

REVIEW OF RELATED LITERATURE
THE POSSIBILITY OF A “FINITE” AND YET “UNBOUNDED” UNIVERSE

The development of non-Euclidean geometry led to the recognition of the fact, that we can cast doubt on the *infiniteness* of our space without coming into conflict with the laws of thought or with experience (Riemann, Helmholtz). These questions have already been treated in detail and with unsurpassable lucidity by Helmholtz and Poincaré, whereas I can only touch on them briefly here. In the first place, we imagine an existence in two-dimensional space. Flat beings with flat implements, and in particular flat rigid measuring- rods, are free to move in a *plane*. For them nothing exists outside of this plane: that which they observe to happen to themselves and to their flat “things” is the all-inclusive reality of their plane.

Let us consider now a second two-dimensional existence, but this time on a spherical surface instead of on a plane. The flat beings with their measuring-rods and other objects fit exactly on this surface and they are unable to leave it. Their whole universe of observation extends exclusively over the surface of the sphere. Are these beings able to regard the geometry of their universe as being plane geometry and their rods withal as the realization of "distance"? They cannot do this. For if they attempt to realize a straight line, they will obtain a curve, which we "three- dimensional beings" designate as a great circle, *i.e.* a self-contained line of definite finite length, which can be measured up by means of a measuring-rod. **Similarly, this universe has a finite area, that can be compared with the area of a square constructed with rods. The great charm resulting from this consideration lies in the recognition of the fact that *the universe of these beings is finite and yet has no limits*.**

Thus if the spherical-surface beings are living on a planet of which the solar system occupies only a negligibly small part of the spherical universe, they have no means of determining whether they are living in a finite or in an infinite universe, because the "piece of universe" to which they have access is in both cases practically plane, or Euclidean. It follows directly from this discussion, that for our sphere-beings the circumference of a circle first increases with the radius until the "circumference of the universe" is reached, and that it thenceforward gradually decreases to zero for still further increasing values of the radius. During this process the area of the circle continues to increase more and more, until finally it becomes equal to the total area of the whole "world-sphere." (Relativity: The Special and General Relativity by Albert Einstein (E – Book) published in 1920; page 128)

THE STRUCTURE OF SPACE ACCORDING TO THE GENERAL THEORY OF RELATIVITY

According to the general theory of relativity, the geometrical properties of space are not independent, but they are determined by matter. Thus we can draw conclusions about the geometrical structure of the universe only if we base our considerations on the state of the matter as being something that is known. We know from experience that, for a suitably chosen co-ordinate system, the velocities of the stars are small as compared with the velocity of transmission of light. We can thus as a rough approximation arrive at a conclusion as to the nature of the universe as a whole, if we treat the matter as being at rest.

We already know from our previous discussion that the behavior of measuring-rods and clocks is influenced by gravitational fields, *i.e.* by the distribution of matter. This in itself is sufficient to exclude the possibility of the exact validity of Euclidean geometry in our universe. But it is conceivable that our universe differs only slightly from a Euclidean one, and this notion seems all the more probable, since calculations show that the metrics of surrounding space is influenced only to an exceedingly small extent by masses even of the magnitude of our sun. **We might imagine that, as regards geometry, our universe behaves analogously to a surface which is irregularly curved in its individual parts, but which nowhere departs appreciably from a plane: something like the rippled surface of a lake. Such a universe might fittingly be called a quasi-Euclidean universe. As regards its space it would be infinite**. (Relativity: The Special and General Relativity by Albert Einstein (E – Book) published in 1920; page 135)

As highlighted from the abovementioned cites of related literature, we can now be able to relate the fact to define immediately the cosmological constant, and that is by means of

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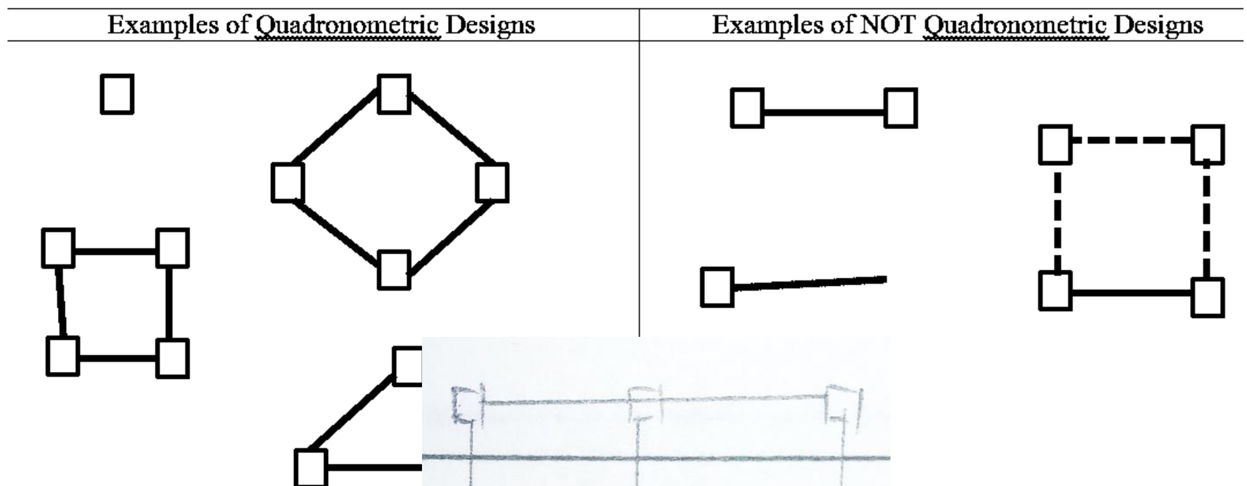
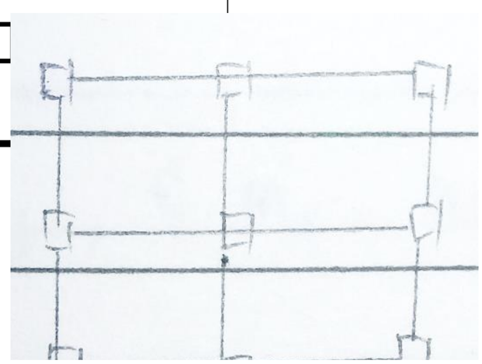
Quadronometry. Let us define what Quadronometry means. Quadronometry is a mathematics of replication of four – sided figures.

Let Q be a quadronometric design that is made up of a little four – sided polygon (denoted by q) or at least one squad design denoted by Q_{sd} (made up of four little four – sided polygons with four solid segmenters/tails).

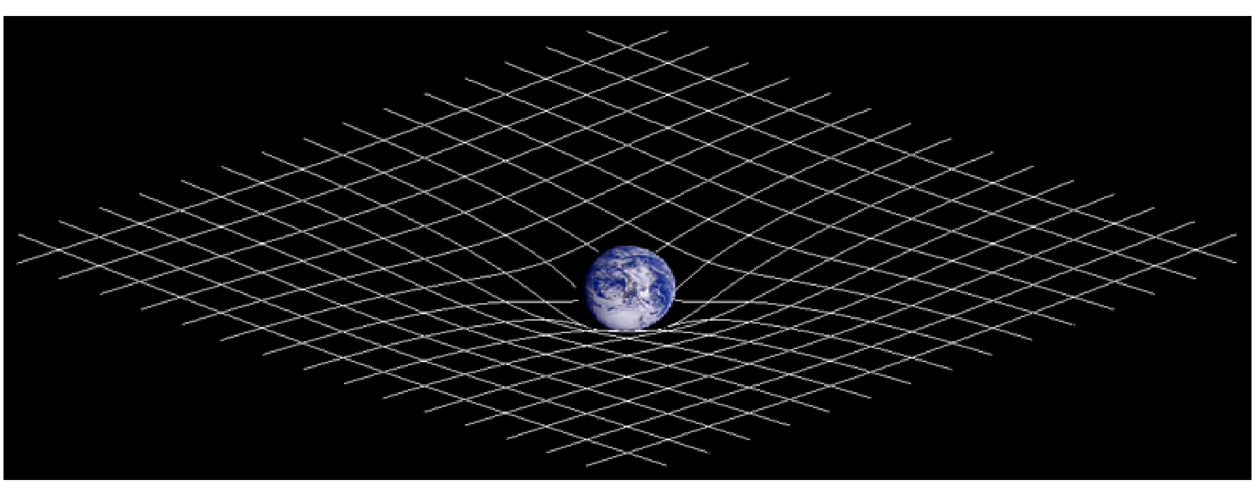




This is what we called "Window" Type of Quadronometric Replica under Row – Column Replication. This is made up of squad designs. The defining equation will be $WinQ_{sd}(n) = \frac{n^2(n-1)^2}{4}$.

This equation proposes to be a defining tool for cosmological constant unit.

The window type of replica will be used to define the spacetime curvature by which it is in a warped orientation in order to find out the number of quadronometric designs to be the cosmological constant unit as seen below:



The earth with some neighborhood matters in space, for example, can define its quadronometric designs collectively by a formula Cosmological Constant$(\Lambda) = \frac{n^2(n-1)^2}{4}$

Where n = the number of matters in space.

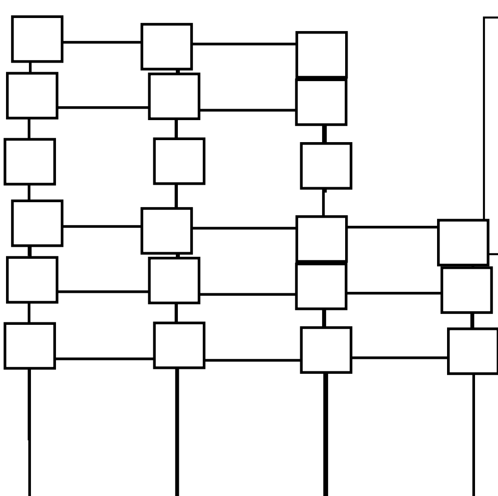
Cosmological Constant is arbitrarily defined by the number of quadronometric designs known as squad designs. The equation was based from inductive reasoning or finding the pattern from the number of squad designs as the number of ranks/no. matters progressively existing.

The number of quadronometric designs will define the warped – like four – sided figures encompassing the specified objects in space. Now let us try to defend on how to come up on the formula of finding the number of quadronometric designs by derivation.

METHODOLOGY AND RESEARCH DESIGN

The research study will make use of documentary and literary review analysis, which is based on the expert opinions of the literary pieces about the published papers of General Relativity according to Albert Einstein. However, we are going to include here the relevance of the Quadronometry concept and its equations to define the spacetime curvature, which is a warped – like four – sided figures.

Going back to the definition of "Window" Type of Quadronometric Replica under Row – Column Replication, showing the figure below:



This is the 3rd rank window whose no. of Q_{sd} = 9. If you are going to replicate until 4th rank, we have the following diagram below:

At 4th rank, there are 36 squad designs. If you are going to move farther the replication in this manner, there would so many squad designs. This is the call for you to use the equation:

$$WinQ_{sd}(n) = \frac{n^2(n-1)^2}{4}$$

This formula from Quadronometry is also a proposal to be a defining tool for cosmological constant unit.

n	1	2	3	4	5	6	7	8	n….
WinQ-$_{sd}$(n)	0	1	9	36	100	225	441	784	$\frac{n^2(n-1)^2}{4}$

Let us now define the Einstein Field Equation (EFE):

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}$$

Where $R_{\mu V}$ – the Ricci Curvature Tensor

R – the Scalar Curvature

$g_{\mu V}$ – the metric tensor

Λ – the cosmological constant; proposed to be defined by

$$WinQ_{sd}(n)= \frac{n^2(n-1)^2}{4}$$

G – the Newton's gravitational constant
C – the speed of light in vacuum
$T_{\mu V}$ – the stress – energy tensor

The EFE is a tensor relating a set of symmetric 4 x 4 tensors. Each tensor has 10 independent components. The four Bianchi identities reduce the number of independent equations from 10 to 6, leaving the metric with four gauge fixing degrees of freedom, which correspond to the freedom to choose a coordinate system.

Although the Einstein Field Equations were initially formulated in the context of a four – dimensional theory, some theorists have explored their consequences in n dimensions. The equations in contexts outside the general relativity are still referred as the Einstein Field Equations.

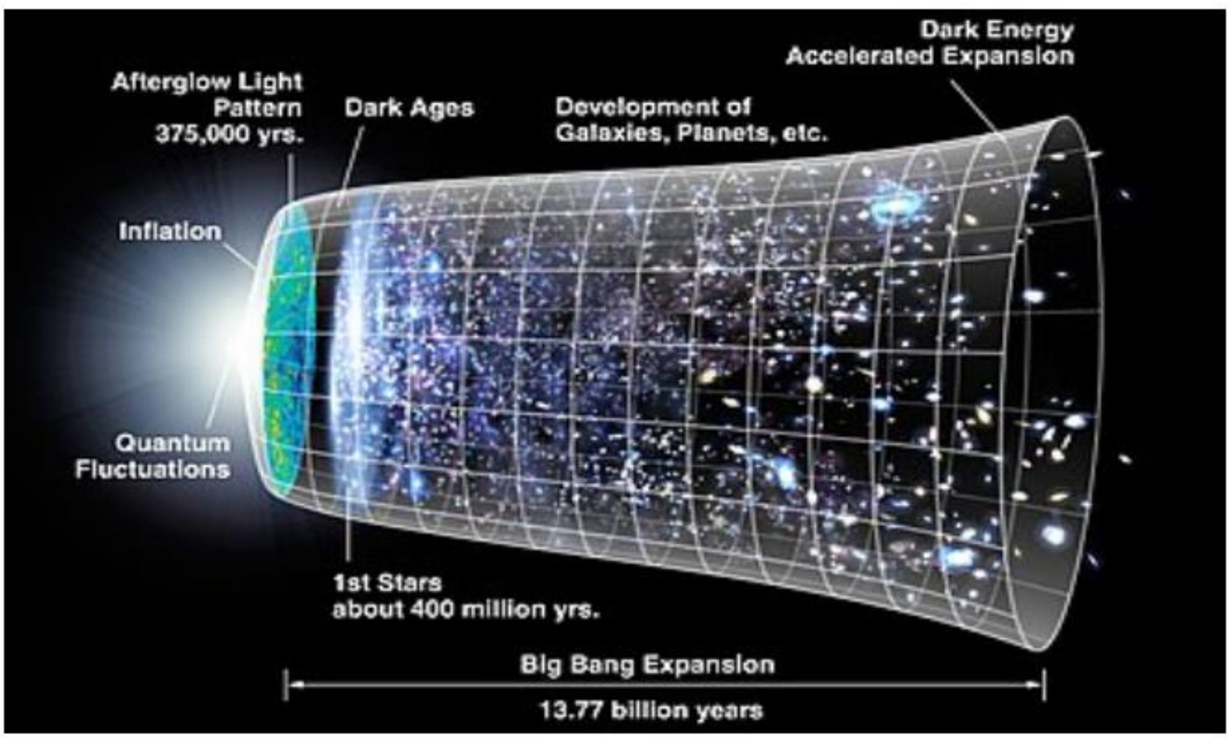
Einstein modified his original field equations to include a cosmological constant term (Λ) proportional to the metric – since it is constant, the energy conservation law is unaffected. The cosmological constant term was originally introduced by Einstein to allow for a universe that is not expanding or contracting. This effort was unsuccessful because:

- The universe described by the general relativity was unstable, and
- Observation by Edwin Hubble confirmed that our Universe is expanding.

So Einstein abandoned cosmological constant term (Λ), calling it the "biggest blunder he ever made." Despite Einstein's motivation for introducing the cosmological constant term, there is nothing inconsistent with the presence of such a term in the equations. For many years the cosmological constant was almost universally considered to be 0. However, recent improved astronomical techniques have found that positive value of Λ is need to explain the accelerating universe. However, the cosmological constant is negligible at the scale of a galaxy or smaller.

This is the call for the Quadronometry's equation $WinQ_{sd}(n) = \frac{n^2(n-1)^2}{4}$

to be equal to the cosmological constant unit since the Universe is expanding and the concept of Quadronometry is the mathematics of replication which definitely fit on how to define the cosmological constant.



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positive nonzero value for the cosmological constant.

Since the 1990's, studies have shown that around 68% of mass – energy density of the universe can be attributed to so – called dark energy. The cosmological constant is the simplest possible explanation for dark energy, and is used in the current standard model of cosmology known as the ΛCDM model.

According to quantum field theory (QFT) which underlies modern particle physics, empty space is defined by the vacuum state which is a collection of quantum fields. All these quantum fields exhibit fluctuations in their ground state (lowest energy density) arising from the zero – point energy present everywhere in space. These zero – point fluctuations should act as a contribution to the cosmological constant, but when calculations are performed these fluctuations give rise to an enormous vacuum energy. The discrepancy between theorized vacuum energy from Quantum Field Theory and observed vacuum energy from cosmology is a source of major contention, with the values predicted exceeding observation by some 120 orders of magnitude, a discrepancy that has been called “the worst theoretical prediction in the history of physics!” This issue is called the cosmological constant problem and it is one of the greatest mysteries in science with many physicists believing that “the vacuum holds the key to a full understanding of nature.”

Einstein included the cosmological constant as a term in his field equations for general relativity because he was dissatisfied that otherwise his equations did not allow, apparently, for a static universe: gravity would cause a universe that was initially at dynamic equilibrium to contract. To counteract this possibility, Einstein added the cosmological constant. However, soon after Einstein developed his static theory, observations by Edwin Hubble indicated that the universe appears to be expanding; this was consistent with a cosmological solution to the original general relativity equations that had been found by the mathematician Friedmann, working on the Einstein equations of general relativity. Einstein reportedly referred to his failure to accept the validation of his equations – when they had predicted the expansion of the universe in theory, before it was demonstrated in observation of the cosmological redshift – as his “biggest blunder”.

In fact, adding the cosmological constant to Einstein’s equations does not lead to a static universe at equilibrium because the equilibrium is unstable: if the universe expands slightly, then the expansion releases vacuum energy, which causes yet more expansion. Likewise, a universe that contracts slightly will continue contracting.

However, the cosmological constant remained a subject of theoretical and empirical interest. Empirically, the onslaught of cosmological data in the past decades strongly suggests that our universe has a positive cosmological constant. The explanation of this small but positive value is an outstanding theoretical challenge, the so – called cosmological constant problem.

CONCLUSION

We define the Quadronometry as the mathematics of replication of four – sided figures. Furthermore, it is a mathematics of infinite imagination of rules to create massive differences after the replication of four – sided figures. Thus, the spacetime curvature which is in a warped – like yet made up of four – sided figures must be applied by this Quadronometry invention.

The expansion of the universe is accelerating with indefinite extents, but some scientific intellects recognized that the universe is finite yet unbounded. To resolve the paradoxical views, we need the formula in Quadronometry as equivalent and defining

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$$WinQ_{sd}(n) = \frac{n^2(n-1)^2}{4}$$

tool for cosmological constant unit since it is the most controversial term that throughout the years, the cosmological constant unit has so many attempts to make it very defined. This is the ambitious attempt of the researcher to make the cosmological constant be well – defined by the given formula as:

$$\Lambda = \frac{n^2(n-1)^2}{4}$$

Where Λ – the cosmological constant
n – the number of objects in a particular area in space

The abovementioned formula of a cosmological constant is an arbitrary constant – meaning that this will be a constant number for some extent in such a way that by considering only the number of objects in some particular areas in space, that would definitely determine what would be the required cosmological constant before we proceed in the Einstein Field Equations (EFE) solutions. This will ensure that the EFE will make its enormous beauty and utilization to define the never – ending expansion of the Universe.

Quadronometry is a great necessity in relativity!

REFERENCES

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