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VARIATION OF THE GRAVITATIONAL CONSTANT AND HE MECHANISM THAT MAKES THE OBSERVABLE UNIVERSE TO GROW

Variación de la constante gravitacional y el mecanismo que hace crecer el universo observable

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Abstract

The Universal Two theories which involve changes over the lifespan of the universe: The Gravitational Constant changes as the universe is expanding. A potential mechanism that drives the Universe growth. This theory also brings forward that Space-Time is another form (thing) interchangeable with matter and energy. Both theories are correlated one to each other. Besides the above-mentioned main subjects, this paper also suggested that the red shift of the light from stars is not due to the Doppler effect as Hubble Law established but the effect of the Higgs Field during their journey toward us. This would explain the not need of Dark Matter. Basically, the two proposed theories have been developed by comparative state of the condition today versus any other age, this gives us the advantage of relative results. The calculation made compared with known parameters and already proven theories, match quite well. Other results cannot be compared because there is not data available or at least known by the author, however, the procedure used is the same as with already known parameter, therefore, such results might be expected to be correct. Based on the results and suggestions in this paper, one can say that

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revisions of some established concept related to Astrophysics might be made to get a better understanding of the universe and its evolution.

Keywords: Gravitation; observable universe; expansion; matter and energy; Doppler effect.

Resumen

Las dos teorías universales, que implican cambios a lo largo de la vida del universo, son: la constante gravitacional, que cambia con la expansión del universo. Este posible mecanismo impulsa el crecimiento del universo. Esta teoría también plantea que el espacio-tiempo es otra forma (cosa) intercambiable con la materia y la energía. Ambas teorías están correlacionadas. Además de los temas principales mencionados, este artículo también sugiere que el corrimiento al rojo de la luz de las estrellas no se debe al efecto Doppler, como estableció la Ley de Hubble, sino al efecto del Campo de Higgs durante su trayectoria hacia nosotros. Esto explicaría la inexistencia de la materia oscura. Básicamente, las dos teorías propuestas se han desarrollado comparando la situación actual con la de cualquier otra época, lo que nos brinda la ventaja de obtener resultados relativos. El cálculo realizado, comparado con parámetros conocidos y teorías ya probadas, coincide bastante bien. No se pueden comparar otros resultados porque no hay datos disponibles o al menos conocidos por el autor. Sin embargo, el procedimiento utilizado es el mismo que con parámetros ya conocidos, por lo que cabe esperar que estos resultados sean correctos. Con base en los resultados y sugerencias de este artículo, se puede decir que se podrían realizar revisiones de algunos conceptos establecidos relacionados con la Astrofísica para lograr una mejor comprensión del universo y su evolución.

Palabras clave: Gravitación; universo observable; expansión; materia y energía; efecto Doppler.

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Introduction

The Universal Gravitational Constant (G) is a cornerstone of modern physics, appearing in Newton's law of universal gravitation and Einstein's theory of general relativity. Conventionally, G is considered a constant, invariant in both time and space. However, this assumption is increasingly being challenged by theoretical considerations and empirical evidence that suggest G may have varied over the history of the universe. This paper proposes a novel theory that G has not remained constant but has instead evolved as the universe has expanded since the Big Bang. Such a variation in G could offer explanations for various cosmological observations, including the nature of early universe dynamics, the formation of large-scale structures, and the observable discrepancies in gravitational effects over cosmological timescales.

It is well accepted by astrophysicists and astronomers that the observable universe is expanding. This paper also proposes a novel theory of the mechanism that makes the observable universe grow.

The gravitational constant G is a fundamental parameter in physics, traditionally considered invariant. However, both theoretical and observational studies have explored the possibility of its variability over time or across different regions of the universe. Early on, Dirac (1937) proposed the Large Number Hypothesis, suggesting that G might vary inversely with the age of the universe. Building on this concept, Brans and Dicke (1961) introduced a scalar field in their theory that could lead to a variable G over cosmological time scales. These ideas have motivated numerous observational efforts, including recent gravitational wave observations (Zhang and Liao, 2018) and constraints from early universe data (Alveyet et al., 2020), to detect or constrain any potential changes in G.

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Observational constraints from methods such as Lunar Laser Ranging and studies of the Cosmic Microwave Background (CMB) have placed stringent limits on the variability of G. For instance, Dickey et al., (1994) used Lunar Laser Ranging data to constrain the rate of change of G to within −10-13 per year, suggesting that any variation must be extremely small but one year is too short period to verify this, if a period of 1,000.000,000 years (1bl) is considered, the results would indicate much foreseeable result, see the attached calculation made. Similarly, Copi and Vachaspati (2004) analyzed the CMB and found that significant variations in G during the early universe would produce observable deviations in the CMB anisotropies, which have not been detected. More recently, studies comparing local (solar system) and cosmological constraints on G have reinforced these stringent limits, offering a comprehensive view of the current state of research (Rana et al., 2017).

Despite the strong evidence for the constancy of G, the possibility of its variation is not entirely ruled out. Theoretical models, such as those proposed by Damour et al., (2002), involving scalar fields, continue to provide mechanisms for potential variability. Moreover, Barrow and Magueijo (2000) explored how a time-varying G could address the cosmological constant problem, suggesting that such variability might explain discrepancies between observed and predicted values of the cosmological constant. Future advancements in observational techniques, particularly from space-based missions and precision gravitational wave measurements, could offer new insights into this fundamental question, either confirming the constancy of G or revealing subtle variations with profound implications for cosmology and fundamental physics (Schlammingeretal., 2021; Uzan, 2003).

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It is also noted that although there is a general agreement about the fact that the observable universe is expanding (growing), there has not been much interest about the mechanism that makes the universe (horizon space-time) to grow. Mostly there have been many calculations about the expanding (growing) speed but not the reason that makes it to expand, therefore this paper too proposes a mechanism which makes the universe grow.

Theoretical Framework

The core hypothesis of this theory is that the gravitational constant **G** was significantly larger in the past and has decreased as the universe expanded. This proposition is grounded in the assumption that the initial state of the observable universe was exceedingly small, following the Big Bang, and has since expanded to the vast size it occupies today. Consequently, it is postulated that **G** was larger in the early universe when the equivalent mass-energy density was much higher.

This assumption aligns with the idea that mass and energy are interchangeable forms, implying that gravitational field, which acts on both mass and energy, permeates every aspect of the universe and the value of **G** might be a consequence of this mass-energy density. Hence, the gravitational field could be compared to electromagnetic fields in terms of its behavior. Just as the magnitude of an electric or magnetic field decreases with increasing distance from a source, the strength of the gravitational field could diminish as the universe expands and the equivalent mass-energy density decreases.

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Mechanism that makes the observable universe to expand (grow).

There is a fact that radiation gets earlier than anything to the observable universe horizon because of its speed. Based on this, this paper also proposes that the radiation getting to the observable universe horizon is transformed to space-time making the observable universe horizon grow. Therefore as time elapse since the Big Bang, there would have been a substantial amount of radiation getting transformed to space-time which decrease the overall amount of energy-matter within the observable universe due to this transformation, contributing to reduce energy-matter density which added to the effect of reducing the density as per the expansion of the universe, which might be the responsible for generating the gravitational field. These two (2) effects that contribute to the decreasing of the observable universe energy-matter density are the key factor for the calculation of the G variation above proposed.

This theory also suggests that the observable universe is a sphere because radiation is always emitted in all directions, therefore the observable universe would grow radially, and the expanding velocity would depend on the value of radiation density (decreasing over the lifespan) that get to the universe horizon. Therefore, the theory presented suggests that its velocity of expansion might decrease consequently.

According to Hubble law the relative speed of any celestial body is calculated by the red shift due to the Doppler effect over the light, but instead it is our suggestion that such red shift might be a consequence of the journey of the light through the HIGGS FIELD, not a Doppler effect related to its speed. This is consistent to what has been observed in spiral galaxies where the speed of stars (according their red shift) are the same no matter at what distance they are from the center of the galaxy, therefore, the similar red shift (the same for all stars in

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spiral galaxies) is because the effect of the HIGGS FIELD over them in their journey toward us (all stars of a galaxy shall be considered to be at the same distance to us considering the astrophysics distance) not due a Doppler effect.

As said above, according to the theory of expansion (growing of universe) proposed, the speed of observable universe should continue decreasing not accelerating. This theory intrinsically implies that space-time as well as energy (radiation) and matter (already consider interchangeable two form of a single thing) is another interchangeable form of that single thing. This would explain the space-time curvature caused by bodies of great gravitational effect as Albert Einstein predicts.

Gravitational Field Dynamics

Under this theory, the gravitational field behaves analogously to electric or magnetic fields. While electric fields are generated by charged particles and magnetic fields by electric currents, the gravitational field should be produced by all mass and energy (equivalent density) in the universe. However, unlike electric and magnetic fields, which are confined between sources, the gravitational field is omnipresent, filling the entire universe.

Currently, the gravitational constant ***G*** is measured as 6.67×10^{-11} Nm^2/kg^2 , representing the field strength today. However, given that the observable universe is continuously expanding and that the equivalent mass-energy density is decreasing, this theory proposes that ***G*** has been decreasing as well. The weakening of the gravitational field is directly related to the expansion of the universe, which reduces the mass-energy density responsible for generating the gravitational field.

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Mathematical Formulation of Gravitational Variation

The theory suggests that ***G*** evolves over time and space, depending on the size of the observable universe and the changing mass-energy density. The relationship is mathematically described as:

$G_X=G_0(1-Rdr_0+Rdr_0(R_0/R_x)^2)(R_0/R_x)^3$

$G_x/G_0=(1-Rdr_0+Rdr_0(R_0/R_x)^2(R_0/R_x)^3$ **G** correction factor according to its age.

Where:

. G_0 represents the current value of the gravitational constant.

. G_x is the value of **G** at any time after the Big Bang.

. R_0 is the present-day radius of the observable universe.

. R_x represents the radius of the observable universe at a given time after the Big Bang.

Rdr_0 is today ($6.83x10^{-12}$) ratio of the energy density of radiation transforming into space-time to particle-energy density. This value is obtained based on that by year 51,000 ($5.1x10^{-5}$bl) after the Big Bang (The Little Book of Cosmology-Lyman Page) the density of radiation was comparable, rather equal than the Particle density.

Rdr_x is any time the ratio of energy density of radiation transforming into spacetime to particle-energy density. $Rdr_x=Rdr_0(R_0/R_x)^2$.

This equation implies that as the universe expanded from a smaller, denser state, the gravitational constant **G** decreased due to the reduction in mass-energy density.

Implications and Cosmological Applications

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Using this model, we can estimate the value of **G** at different epochs of the universe's history. For instance, events that occurred approximately 11 billion years after the Big Bang would be associated with a value of **G** nearly twice as large as the current value. As such, gravitational interactions at that time would have been considerably stronger than they are today, potentially leading to more rapid formation of structures such as stars, galaxies, and black holes.

When applied to the cosmological situation 2 billion years after the Big Bang, this model predicts that ***G*** was approximately 328 times larger than its current value. Such an increase in gravitational force would have significantly affected the dynamics of astrophysical objects, suggesting that massive structures like black holes would have been much less massive than what has been estimated today, due to the stronger gravitational effects. Also, the gravitational waves might be affected as their means to travel might be by the gravitational field, therefore, based on any wave behavior, their speed of traveling might be decreasing as the strength of the gravitational field decrease, according to what this theory proposes.

Impacts on Dark Matter and Dark Energy Theories

This theory also offers potential insights into the nature of dark matter and dark energy. The extra gravitational effects observed in distant galaxies, often attributed to dark matter, could be explained by the higher values of *G* at the time those gravitational interactions occurred. Similarly, the concept of dark energy, invoked to explain the accelerated expansion of the universe, might be reconsidered. Both dark matter and dark energy could be explained by understanding the way that the HIGGS FIELD affect light (let´s say degrades it to

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red shift) in its journey toward us, e.g. the relative speeds of the astro bodies may not be that as per Hubble Law predict.

As the universe expanded rapidly after the Big Bang, driven by high radiation density, ***G*** decreased, leading to the observed slowing of the expansion rate as this theory proposes.

Therefore, this expansion may stop if the radiation energy that makes the universe grow diminishes following a contraction due to gravity domination. There has been some proposal regarding this fact, suggesting that the universe may be a continuing process of expansion and contraction.

Results

Below there are ten (10) equations that have been used for calculating various parameters. The following are the basics which support them. Mainly they are focusing on comparative values which influence the concepts involved in supporting these hypotheses. It has been stated that the radiation plus particle densities today have been assigned the value of 1 (per unit system), also the diameter of the observable universe is considered as proportional to its age, therefore, all results obtained at any time are on basis of their relative changes, e.g. the density two (2) billion years ago as considered proportional to the inverse of the cubic of the radio (if we dismiss for simplicity the effect of radiation transformation in space-time) of the observable universe would be $(RE_0+ME_0)(R_0/R_x)^3$, where R is the age of the observable universe since the Big Bang, which in this case would be $(13.8/11.8)^3$. This will give a comparative value to the current density that has been assigned with the value of one (1). Following are the equations mentioned:

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Rdr_o= $RE_o/(RE_o+ME_o)$=Today´s ratio of equivalent* radiation density to equivalent particle-radiation of the observable universe.

$RE_o+ME_o=1$ Today´s equivalent particle plus radiation density in “pu”.

$Rdr_x=RE_x/(RE_x+ME_x)=Rdr_o(R_o/R_x)^2$ Ratio of radiation density to particle-radiation density any time. Position 3 and 7.

$Rdr_x(RE_x+ME_x)=RE_x$ $Rdr_x(RE_x+1+Rdr_x-RE_x-Rdr_o)=RE_x$ $RE_x=Rdr_x^2+Rdr_x-Rdr_oxRdr$ Radiation density at any time. (position 3, 4 and 10)

$RE_x + ME_x$= Particle plus radiation density any time per unit, see position 2.

$Rdmx= ME_x/(ME_x+RE_x)$. Ratio of particle density to particle-radiation density at any time.

$Rdr_x=Rdr_o(R_o.e/R_x.e)^2=Rdr_o(R_o/R_x)^2$ Ratio of radiation density to particle-radiation density based on the transformation to space-time at any time. Where “e” (symbolic) is the thickness of the observable universe barrier limit.

$MRd_x=1-Rdr_o+Rdr_o(R_o/R_x)^2$=Particle-Radiation density variation due to radiation transformation to space-time.

$G_x=G_oxMRd_x(R_o/R_x)^3=G_o(1-Rdr_o+Rdr_o(R_o/R_x)^2)(R_o/R_x)^3$ Position 8 and the fundamentals of this theory which propose that the **G** evolves inversely proportional to the cubic of the size of the universe.

$ME_x+RE_x=1+Rdr_x-Rdr_o$=Particles-Radiation density any time just due to Radiation transformation to space-time.

$ME_x= 1+Rdr_x-Rdr_o-RE_x$=Particles density any time

The ratio G_x/G_0 Calculated as per this proposed theory compared to calculation according to Newton law is quite comparable. If we consider an average of 4.25cm per year (moon drifting away of earth), during one billion (1Bl) year the G_x/G_0 will match perfectly. This makes sense because the variation of G is inversely proportional to third power meanwhile the radio, according to Newton Law by the second power, it brings forward that every year the moon drift away of earth a little longer.

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Table 1

G *variation proved by the Moon drifting away (already known per year) of Earth*.

MOON DRIFTING AWAY OF EARTH			
riation as per universe size one billion (1Bl) year older		**n Moon drifting away per year**	
$G_x/G_0=(1-Rdr_0+Rdr_0xR_0^2/R_x^2)(R_0^3/R_x^3)$		**Newton law**	
Rdr_0	6.83E-12		**Mxm/R^2**
G_x/G_0	0.810684954494	**adjusted factor ($G_x/G_0=R_0^2/R_x^2$) 1B year based on 3.82cm per year drifting away**	0.8274241503
		Average radio Moon to Earth km	
$R_x=R_0$ plus 1Bl year	14.8	**1Bl year later**	422,700.00
R_0	13.8	**Today**	384,500.00

Table 2

Estimated Earth-Sun distance variation due to ***G*** *variation*

EARTH DRIFTING AWAY OF SUN BY 1 BL years		
Distance that Earth get farther from Sun 1Bl year later		
arth current distance to Sun is 150 millions km	**150,000,000.00**	
is the distance Earth to Sun 1Bl year later based on **G** variation		
R_x		ırs since the Big Bang
R_0		s Bl. Years since the Big Bang
G_x/G_0=$(1+Rdr_0+Rdr_0xR_0^2/R_x^2)xR_0^3/R_x^3$	584954	ction factor
Earth to Sun 1B year later	96,242.76	
Earth farther of Sun 1B year later	5,242.76	

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Table 3

*Estimated Moon-Earth distance due to **G** variation*

ESTIMATED DISTANCE MOON TO EARTH 2 BLs. years ago			
R_x	11.8	rs since the Big Bang	
R_0	13.8	´s Bl years since the Big Bang	
$\mathbf{G_0}$	6.67E-11		
Present distance Moon to Earth	384,000.00		
correction factor 2Bl yr ago	1.599525755		
$\mathbf{G_x}$ 2Bl years ago	1.06688E-10		
ıce Moon to Earth 2Bl yrs ago	**303,623.66**		

Table 4

*Estimated Earth-Sun distance due to **G** variation*

ESTIMATED DISTANCE EARTH TO SUN 2Bl years ago			
R_x	11.8	rs today since the Big Bang	
R_0	13.8	´s Bl years since the Big Bang	
$\mathbf{G_0}$	6.67E-11		
Today´s distance Earth to Sun	150,000,000.00		
correction factor for 2Bl yrs ago	1.599525755		
$\mathbf{G_x}$ 2Bl year ago	1.06688E-10		
ıce Earth to Sun 2Bl year ago	**118,602,990.71**		

Conclusions

In conclusion, the theory (3A) proposes that the gravitational constant G has not remained fixed since the Big Bang but has instead decreased as the universe expanded and its mass-energy density diminished. By varying over time and space, G could explain many cosmological phenomena, including the early formation of

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massive astrophysical objects, the extra gravitational effects observed in distant galaxies, the early formation of heavy elements, small very bright stars at very beginning and even the mechanisms underlying dark matter and dark energy.

This evolving gravitational constant presents a new avenue for theoretical and observational research, challenging the traditional notion of a fixed G and offering fresh insights into the fundamental forces shaping the universe. Future observational efforts, particularly those involving precision measurements of cosmic expansion and structure formation, will be crucial in testing this theory and its implications for modern cosmology.

The theory (3B above) proposes the mechanism that make the observable universe grow, introduces major step regarding the observable universe expansion speed as well as how it affects the energy-matter density which influence the changing of G. Also, it proposes that the universe might be a sphere as well as its expansion speed (growing) might be decreasing and that the red shift observed over astrophysics bodies could be related to the light affected by the HIGGS FIELD not by a Doppler effect, which means that the measurement of the relative speed of the astrophysics bodies would have to be reviewed.

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