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Concerning Dark Matter after excluding the FLRW metric (and with it, Dark Energy)

Somewhere in the discussion there are questions and answers to ChatGPT, our Artificial Intelligence (see <https://openai.com/>), to know his thought and fill the gap in knowledge.

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ABSTRACT

We will discuss the existence of Dark Matter and show how much this entity is mainly necessary to justify the *FLRW* metric of Λ CDM. Speaking about galaxies, of recession, orbits and gravitational lenses, we will also show that, once we hypothesize a different velocity for the Galactic Recession, its introduction into our physics is probably no longer necessary.

DISCUSSION

As an alternative to the Standard Model Λ CDM with its metric *FLRW*, this brief analysis refers to the cosmological model named "[4-Sphere](#)".

Dark Energy has been excluded in 4-Sphere among the forces that govern the equilibrium of the Universe in its shape. More precisely, the conjecture predicts that the Universe in its expansion crosses a continuum of states of equilibrium between gravity and pressure of the *CMB*.

Due to the Universe expansion every point recedes together with the *CMB* that surrounds it. By construction of this model, a traveler perceives the *CMB* as if every point of the Universe were a source. For a particle with its own peculiar velocity, it follows that effects such as radiation friction cannot be attributed to *CMB*, even in a minimal form.

Between two approaching stars, the only force that opposes gravity is the radiation pressure which they exercise over each other. But then, before the first star appeared and neglecting the radiation of the gas, no force could counteract the gravity between two particles moving away from each other due to the Galactic Recession.

It is in this context that we must consider Dark Matter, that is how, in its absence, a primordial halo of gas formed and evolved.

We can see that, while with *FLRW* the Recession Velocity v_r increases over time, as a force against gravity $a(t)$, with 4-Sphere it remains constant, resulting also much smaller. This is a major drawback to Dark Matter.

In 4-Sphere, we get a sense of the problem by simplifying math to the maximum:

Assuming a current matter density of $3 * 10^{-28} Kg m^{-3}$ conserved over time and made up in the early days of 75% of Hydrogen and 25% of Helium, the mean weight of an atom of gas is $2.92 * 10^{-27} Kg$. Then, considering two alone neighboring atoms soon after the Last Scattering, we get to the condition $v_r = \int_0^t a(t)dt$ a few years later. (The math expression of $a(t)$ contains a not negligible recursion term, and the result is highly dependent on the initial density and its fluctuations, but acceptable with respect to secular evolution of galaxies).

In this context, also thinking about the spin of very old galaxies, I asked the opinion of ChatGPT, our artificial intelligence.



I: Can two primordial halos of gas approaching by gravity enter orbit and acquire spin in a similar way to two galaxies?



AI: Yes, it is possible for two primordial halos of gas to approach each other by gravity, enter into orbit, and acquire spin in a similar way to two galaxies. In fact, this is thought to be the mechanism by which galaxies themselves form.

In the early universe, matter was distributed very unevenly, with denser regions of gas and dark matter called halos forming around the slightest over-densities. As these halos grew by accreting more matter from their surroundings, they began to gravitationally attract other halos nearby.

If two halos were to approach each other closely enough, they could enter into orbit around each other, and their mutual gravitational attraction would cause them to spin. Over time, this spinning motion would cause the gas and dark matter to flatten into a disk-like structure, which could eventually collapse to form a galaxy.

So, while individual atoms are not likely to form orbits around each other due to gravity, larger structures like primordial halos of gas can indeed form orbits and acquire spin through the force of gravity.

To conclude this aspect, the execution of the few lines of code [1] gives us an idea of how much the Recession Velocity itself makes the Dark Matter necessary or not.

Furthermore, as far as astronomical observations are concerned, although physical models are built such to resolve any inconsistency [*], the presence of Dark Matter is not yet proven, being the effects attributed to it also explained differently. The case in point concerns the rotation curve of galaxies in which the expected decrease in speed in the orbits of stars, beyond a certain distance from the center, does not appear, in contravention of Kepler's laws.

An explanation for this is given in [**]:

“In particular, the measured rotation curve of galaxies provided much experimental support to the dark matter concept. However, most theories used to explain the rotation curve have been restricted to the Newtonian potential framework, disregarding the general relativistic corrections associated with mass currents.”

This is a new approach in which, due to the coexistence of stars, gas and dust in the galaxy, the classical concept of balance between gravitational and centrifugal forces is replaced by a set of equations for the motion of a perfect fluid in a gravitational field. The approximation applied is that of the weak fields, through the analogy named “Gravitoelectromagnetism”.

“In the present article a new model for the rotation curve of galaxies is developed including the effects associated with mass currents. A set of equations that govern the motion of a weakly relativistic perfect fluid is introduced ...”

The article in question was chosen among others because it proposes a solution inside General Relativity, not wanting (for now) to resort to modified gravitational theories as “Bigravity” [***] or others, which also offer different explanations to Dark Matter.

According to what has been said we should not think in terms of abundance or scarcity of dark matter in a galaxy, but rather in terms of lower or higher concentration of its mass at the center.

Speaking of different observational evidence, the results from measurements are sometime affected by the assumptions of the cosmological model used. In gravitational lenses [****], similarly to classical optics, the geometry of the lens, in its equation, relates the distances between star, lens and observer as explained in [*****] at point 2 “Basic of Gravitational Lensing”.

Now, to calculate the angle of deflection we must know the distances from the observer to the plane of the source, where the star lies, and to the plane where lens is. Their estimate, given the order of magnitude, could only be calculated starting from the respective Redshifts, according to the metric used.

In the lens equation, the smaller the ratio between the distances from the "lens" and from the "source", the more the mass of the "lens" and its distance from us become directly proportional. In the practical case however, this dependence on the model is not too accentuated.

The article [****] in TABLE 1 lists a set of lens systems. The first it is about SDSS J0029-0055, a source object placed at $z = 0.931$ in alignment with the observer and with a foreground $z = 0.227$ elliptical galaxy working as a lens.

With $H_0 = 70 \text{ Km s}^{-1} \text{ Mpc}^{-1}$ for FLRW the distances are:

$$\begin{array}{ll} \text{— FRLW} & d_{source} = 10,211 \text{ Mpc} \quad d_{lens} = 1,895 \text{ Mpc} \\ \text{— 4-Sphere} & d_{source} = 1,856 \text{ Mpc} \quad d_{lens} = 773 \text{ Mpc} \end{array}$$

Applying now the lens equation to get the same Einstein Angle we find the relation between the lens masses computed by the two models, for the case in question:

$$\frac{m_{4-Sphere}}{m_{FLRW}} = 0.57 \text{ approximately}$$

But different assessment of the stellar distances between the two models is not limited to this.

Knowing the Mass-to-light ratio Υ of the study and assuming its constancy, we could find another relationship between the two models that links the mass of the elliptical galaxy (the lens) to its Luminosity:

$$\text{if } \frac{m}{L} = \Upsilon = \text{const} \quad \text{then } \frac{m_{4\text{-Sphere}}}{m_{FLRW}} = \frac{L_{4\text{-Sphere}}}{L_{FLRW}}$$

but the calculation of the K correction is different between 4-Sphere and FLRW and this does not allow to "convert" the Absolute luminosity computed for the lens.

Even if we have no comparison for the over 27% expected extra mass by the authors (which we lack instead) we showed the dependence of the lens on the model.

Furthermore, a difference in the light deflection angle, as for the stars orbit, could also be due to the fact that, inside the galaxy and just outside its surface, the spacetime geometry could not be based on the Schwarzschild line element. It is true that Gravitoelectromagnetism analogy (more suited to the spiral galaxy) gives the same light deflection of Schwarzschild metric but, as an approximation, it might not yet provide all the answers to the galaxy's unexpected behavior. In calculating the lens for the elliptical galaxy, the overall rotary motion is perhaps negligible, but its magnetic fields [*****] may not be.

Here's what ChatGPT thinks:



I: Can we say that the magnetic field present in an elliptical galaxy contributes to the gravitational lensing effect?



AI: Yes, the magnetic field present in an elliptical galaxy can contribute to the gravitational lensing effect. Gravitational lensing occurs when the light emitted from a distant source is bent by the curvature of spacetime caused by the presence of mass between the source and the observer. This bending of light can also be influenced by the distribution of matter and energy in the region between the source and observer, including the magnetic field.

In particular, the magnetic field can affect the path of light through the Faraday effect, which describes the rotation of the polarization plane of light as it passes through a magnetic field. This can lead to an additional gravitational lensing effect beyond that due solely to the presence of visible matter. However, magnetic effects in gravitational lensing are generally much weaker than gravitational effects and require very sensitive instruments to detect.



I: Can we say that an elliptical galaxy in its complexity, with its mass not concentrated in one point, could deflect light as a gravitational lens not following the Schwarzschild metric?



AI: Yes, it is possible for an elliptical galaxy to deflect light as a gravitational lens in a way that does not follow the Schwarzschild metric. The Schwarzschild metric is a mathematical description of the curvature of spacetime around a spherically symmetric mass, such as a black hole or a point-like object. However, in a complex object like an elliptical galaxy, the mass is not concentrated in one point, and the gravitational field is not spherically symmetric.

In this case, the lensing effect is described by a more complex mathematical model, such as the Navarro-Frenk-White (NFW) profile or the Singular Isothermal Sphere (SIS) model. These models take into account the non-spherical and non-uniform distribution of mass in the galaxy and can produce lensing effects that deviate from the predictions of the Schwarzschild metric.

Additionally, the presence of other galaxies, galaxy clusters, or dark matter in the vicinity of the elliptical galaxy can also affect the lensing effect and lead to deviations from the Schwarzschild metric. These effects can be studied using sophisticated computer simulations and observations of the lensing effect.

To conclude, the objective of this brief analysis is not to refute the existence of Dark Matter (since it is not a directly measurable entity, it is up to others to prove its existence). Here, I wanted to bring to attention how much functional it is to the hypothesized model chosen for galactic recession, while probably it is not to our physics. Talking about it is a must because of its importance.

[*] – I do not find it objectionable to hypothesize a physics for a particle whose existence has yet to be demonstrated. Indeed, even if not verifiable, I consider it a necessary completion of a conjecture: through this, we can arrive at contradictions or even just to verify if, and how much, we are moving away from our perception of reality. [\[The Astrophysical Journal, Volume 880, Number 2\] – The Motions of Dark Matter](#)

[**] – [The European Physical Journal C volume 81, Article number: 186 \(2021\) - Galactic rotation curve and dark matter according to gravitomagnetism](#)

[***] – [\[arXiv:1809.05318\] – Long Range Effects in Gravity Theories with Vainshtein Screening](#)

[****] – [\[arXiv:astro-ph/0701589\] – The Sloan Lens ACS Survey. IV. The Mass Density Profile of Early-Type Galaxies out to 100 Effective Radii](#)

[*****] – [\[DOI:10.3390/universe2010006\] – The Scales of Gravitational Lensing](#)

[*****] – [\[arXiv:2012.02329\] – Magnetic fields in elliptical galaxies: an observational probe of the fluctuation dynamo action](#)

[1] – Here the VBNET code used to check my conclusions about Dark Matter (In the interval studied, the velocity of recession decreases slightly over time but we are interested in verifying that the approach between the atoms begins in an acceptable time. The exact calculation would increase the processing time.):

```

'
'   Number of atoms 7.24e11/m^3 at Last Scattering (with timeLine = 720,000 years)
'
Const recessionVelocity As Single = 4.90437E-18
Const atomsInitialDistance As Single = 0.000111349
'
'   Need Dark Matter? (for a WinForms project)
'
Private Sub NeedDarkMatter(recessionVelocity As Single, atomsInitialDistance As Single)
    Const gravityComponent As Double = 1.94511E-37 ' gravitationalConstant * one mass
    Const timeIncrement As Integer = 100 ' in seconds
    Dim atomsDistance As Double = atomsInitialDistance
    Dim incrementDistance As Double
    Dim relativeVelocity As Double = recessionVelocity
    Dim gravityAcceleration As Double = gravityComponent / atomsDistance ^ 2
    Dim timeElapsed As Single = 0
    For i As Long = 0 To 1000000000000000
        timeElapsed += timeIncrement
        incrementDistance = relativeVelocity * timeIncrement
            - 1 / 2 * gravityAcceleration * timeIncrement ^ 2
        atomsDistance += incrementDistance
        gravityAcceleration = gravityComponent / atomsDistance ^ 2
        relativeVelocity -= gravityAcceleration * timeIncrement
        If incrementDistance <= 0 Then
            Dim years As Integer = timeElapsed / 31500000.0 ' seconds per years
            MessageBox.Show("Start of approach after " + years.ToString + " years.")
            Exit Sub
        End If
    Next
    MessageBox.Show("Approach not started within the execution time limit")
End Sub

```