Could the Diameter of The So-Called Inflated Universe Actually be the Hubble Circumference?

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May 18, 2021

Abstract

This short paper points out that the so-called diameter of the inflated universe, approximately $\Theta \approx 8.8 \times 10^{26}$ m, basically is very close to or perhaps even identical to what we can call the Hubble circumference: $\Theta \approx 2\pi R_h = 2\pi \frac{c}{H_o}$, at a Hubble constant of 66 (km/s)/Mpc these values are identical. The question is if these facts are a pure coincidence or if the diameter of the so-called inflated universe truly could be directly linked to the Hubble circumference? Further, we discuss some possible implications on suggested minimum acceleration models that, in this interpretation, seems to fit galaxy rotations well without relying on dark matter. In particular, the "recently" introduced quantized inertia model seems robust in its predictions under this perspective. Inside the uncertainty, we can find in the various measurements of the Hubble constant.

Keywords: Hubble constant, Hubble sphere, observable universe, the inflated universe, diameter of the universe, galaxy rotation, minimum acceleration theories, Schwarzschild radius.

1 Introduction

The Hubble constant came out of empirical observations that most galaxies (and other heavenly objects) were red-shifted. There was a linear relationship between this observed redshift and our distance from these heavenly objects. This fact has been interpreted as the expansion of space in the Λ-CDM model. Further, the Hubble radius is simply the speed of light divided by the Hubble constant. Naturally, one must here be sure to express the Hubble constant in the right units (1 divided by seconds, SI units). A Hubble constant of 70 $(km/s)/Mpc$ means a Hubble radius of $R_h = \frac{c}{H_0} \approx 1.32 \times 10^{26}$ m. This calculation is considered the radius of the observable universe before inflation, also known as the radius of the flat universe or the critical universe, where Euclidean geometry still holds. When one has set Λ and k both equal to zero, in the Friedmann [1] equation, that again is rooted in general relativity theory. There is considerable uncertainty in both the Hubble constant and, therefore, in the Hubble radius and the diameter of both the critical and the inflatable universe. One can find the same radius by taking the assumed life of the universe 13.8 billion years (that is simply 1 divided by the Hubble constant) to see how far light can travel in this time, which naturally again is $\frac{c}{H_0}$, because the age of the universe is considered by standard cosmology to be one divided by the Hubble constant.

One can talk of the Hubble sphere. This sphere has a radius equal to the Hubble radius. This number is the same as the radius of the so-called critical universe, which is a universe without inflation or contraction. The circumference of this sphere is $2\pi R_h \approx 8.3 \times 10^{26}$ m. With a Hubble constant of $H_0 = 66$ $(km/s)/Mpc$ we get a circumference of approximately 8.8×10^{26} m. This calculation is very close to today's assumed diameter of the observable universe after the assumed inflation [2] (expansion of space), $\Theta \approx 8.8 \times 10^{26}$ m (93 billion light-years). So, we think one natural question to ask is if the circumference of the Hubble sphere could have special effects or cause special properties for what we observe in the universe that perhaps could replace the expansion hypothesis. If so, this assertion would likely strongly indicate that the diameter of the so-called inflated universe, in reality, could be the circumference of the Hubble sphere (in the critical universe). If this calculation is the case, we do not have the answers, but we definitely think this phenomenon could be worth investigating further.

2 Possible Implication on Minimum Acceleration Models That Explain Galaxy Rotation Without the Need for Dark Matter

In recent years McCulloch [3–5] has linked a theory he has coined quantized inertia to the diameter of the inflatable universe. Suppose the diameter of the inflatable universe, Θ, instead could be directly linked the circumference of the Hubble sphere. In that case, this assertion could have multiple consequences for interpreting his theory and other theories, including the interpretation of the Λ-CDM model. Both McCulloch [6] and Haug [7] have respectively linked the diameter and the radius of the inflatable universe, Θ, to two different models that fit galaxy observations more or less without introducing the dark matter hypothesis. The McCulloch model predicts a gravitational acceleration of

$$a_{predicted} = a_{bar}\sqrt{1+\frac{2c^2}{a\Theta}} \tag{1}$$

If Θ should be linked directly to the Hubble circumference, we could re-write the McCulloch quantized inertia gravitational acceleration prediction equation [6] for galaxy rotation as

$$a_{predicted} = a_{bar}\sqrt{1+\frac{2c^2}{a_{bar}2\pi R_h}} = a_{bar}\sqrt{1+\frac{c^2}{a_{bar}\pi R_h}} = a\sqrt{1+\frac{c^2}{a_{bar}\pi\frac{c}{H_0}}} = a_{bar}\sqrt{1+\frac{cH_0}{a_{bar}\pi}} \tag{2}$$

where a_{bar} is the standard gravitational acceleration from bayronic matter only, so simply $a_{bar} = g = \frac{GM}{R^2}$. The recently suggested Haug [7] model for galaxy rotation is given by

$$a_{predicted} = a_{bar} + \frac{GM_u}{R_u^2} = a_{bar} + \frac{GM_u}{(\frac{1}{2}\Theta)^2} = a_{bar} + \frac{4GM_u}{\Theta^2} \tag{3}$$

where M_u is the mass in the mass of the universe, in a flat Friedmann universe (before inflation) this number would be the critical mass $M_u = M_c = \frac{1}{2}\frac{c^3}{GH_o}$, see for example Weinberg [8]. Now again, if Θ is replaced with the circumference of the Hubble sphere the acceleration given by Haug could be re-written to be

$$a_{predicted} = a_{bar} + \frac{4GM_u}{\Theta^2} = a_{bar} + \frac{GM_u}{\pi^2 R_h^2} = a_{bar} + \frac{G\frac{1}{2}\frac{c^3}{GH_o}}{\pi^2\left(\frac{c}{H_0}\right)^2} = a_{bar} + \frac{cH_0}{2\pi^2} \tag{4}$$

Figure 1 shows 2793 observed individual data points as black dots from 153 galaxies from the Spitzer Photometry and Accurate Rotation Curves (SPARC), see also [9]. The light green line with the green circle dots is the MOND [10] model, which is a minimum acceleration curve fitting model that can almost be seen as a benchmark in the best possible fit. The model lacks an explanation behind the minimum acceleration. In the same figure, we can see the predictions from quantized inertia with Θ set equal to the Hubble circumference $2\pi R_h = 2\pi\frac{c}{H_0}$. There are wide differences in the measurements for the Hubble constant even in recent times, for example in 2021 Soltis et al. [11] measured to be $H_0 = 72 \pm 2$ $(km/s)/Mpc$, while for example Mukherjee et al. [12] in 2020 measured the Hubble constant to be 67.6 ± 4.2 $(km/s)/Mpc$, and Friedmann et al. [13] in 2019 measured it to $H_0 = 69.8 \pm 0.8$ $(km/s)/Mpc$. In general, we can say with high certainty that the Hubble constant is between 60 and 80, see also [14–16]. From figure 1, we see estimated values in the McCulloch model and the recent Haug model for Hubble constants 60, 70, and 80.

In particular, we see that the quantized inertia model. from this speculative perspective also fits the observations very well for all Hubble constants inside the range where it likely lays (in between 60 to 80). The Haug model also fits well, but less so on the left end of the graph. This model is non-relativistic. Therefore, relativistic effects should be considered added to the model and analyzed before this model is excluded. One should also consider if the quantized inertia model properly considers the relativistic effects and if there are any important relativistic effects to consider for the minimum acceleration of galaxy rotation. One could think relativistic effects not is important for the minimum acceleration since, in general, it is likely of interest for low velocity, low gravitational-field environments. Of these two modified models, the quantized inertia model fits the data somewhat better than the Haug model. However, several other minimum acceleration models have been suggested in recent years [17, 18], and it is high time for the research community to investigate the minimum acceleration idea and its various models in more detail. Of these models, only the Modified Newton Dynamics (MOND) is widely known in the research community, partly because it was published already in 1983. However, the MOND model is more of a curve-fitting model with a free parameter than a model that asserts the reason for the minimum acceleration. Therefore, these other models that also try to explain the cause of the minimum acceleration should be investigated carefully before any premature conclusions are made.

Suppose Θ should be related to the Hubble circumference in reality and additional models. For example, the quantized inertia model should aso prove to be a sound foundational model. In that case, the optimal match regarding the galaxy rotation data could even help to decide on a more accurate value of the Hubble constant. But, as we see, the model under this interpretation is not very sensitive to the Hubble constant, so it would likely be of little help in deciding on the more precise value of the Hubble constant, but it could possibly help to some extent. Further investigation is needed.

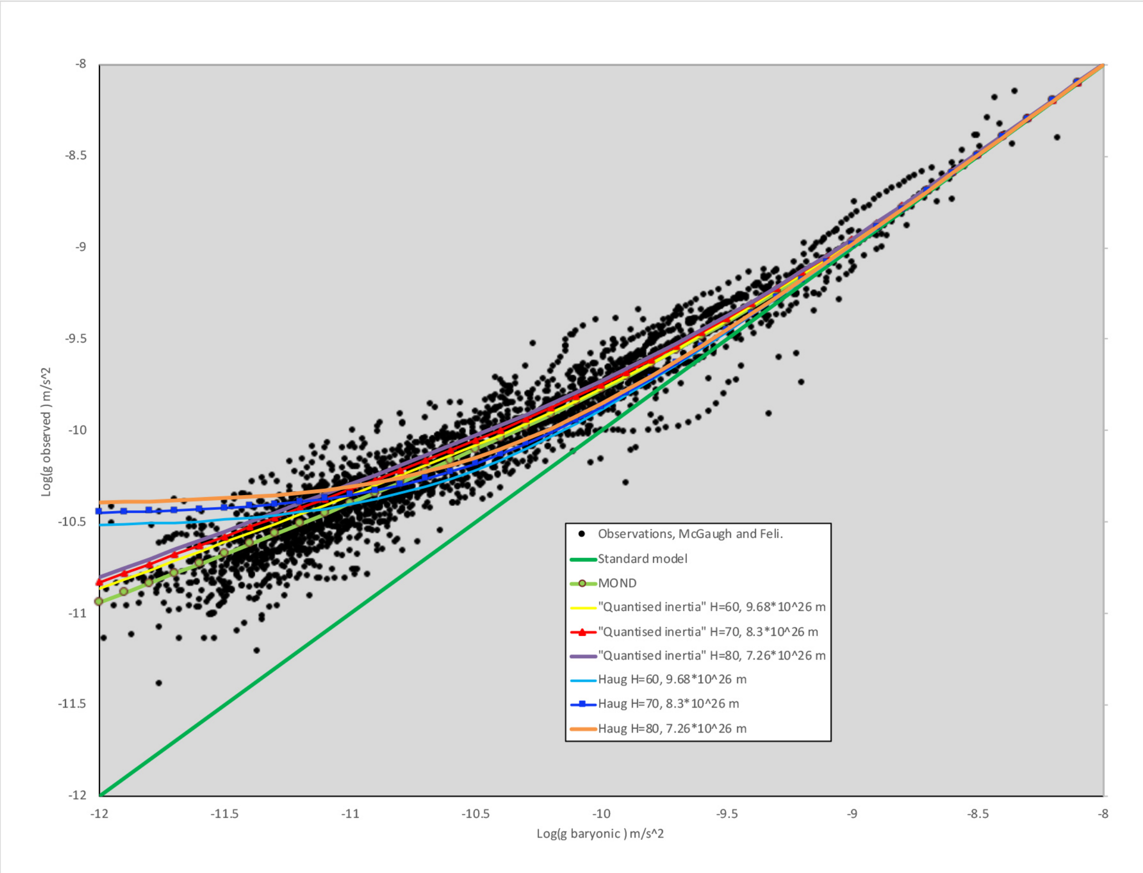

Figure 1: Galactic accelerations. The black dots are 2793 observations from the Spitzer Photometry and Accurate Rotation Curves (SPARC) database. In addition, we show the prediction from MOND, from quantized inertia as well as the Haug model under this suggested hypothesis that the inflated radius in reality could be the Hubble sphere circumference.

3 Minimum frequency of electromagnetic waves in the Hubble sphere?

Another interesting idea to investigate in this respect is if there could be any signals travelling around the Hubble sphere circumference. Around the circumference of the Earth, Schumann resonance waves [19] are known to travel. This fact was predicted already in 1893 by FitzGerald [20], so they are also known as "Schumann-FitzGerald resonances". It takes about 0.13 seconds for electromagnetic waves to travel around the Earth (in the ionosphere), leading to an expected frequency of approximately 7.5 Hz. The observed Schumann resonance waves are in this frequency range. The "exact? frequency depends on how high up in the atmosphere (ionosphere) the waves travel and other factors. The conductive ionosphere acts as a closed waveguide. The cause of the Schumann resonance is considered linked to lightning storms in the atmosphere, where part of the electromagnetic waves travels around the Earth. Could there be similar very low-frequency electromagnetic waves that travel around the circumference of the Hubble sphere? That the Hubble radius is identical to the Schwarzschild radius [21, 22] of a sphere with the expected mass density of our universe could mean this horizon and this circumference are very special. Some researchers [23, 24] have even asked if we could live inside a gigantic black hole. Others have asked if our universe was created from a black hole [25]. Therefore, That one could have special electromagnetic events linked to the Schwarzschild radius and Schwarzschild circumference of the critical universe is far from unthinkable, or perhaps even expected. The question is if these events can lead to waves travelling around the whole circumference of the Hubble sphere and perhaps spill over into the Hubble sphere? Bear in mind that there could be a series of different interpretations of a "black-hole" universe. Even Newton's theory [26, 27] predicts that for a given mass density that one will get a sphere with an escape velocity c. So, in more general terms, this sphere could be a sphere filled with a given density of matter (over cosmic scales) where the escape velocity is c at the circumference of the sphere. Different theories could lead to different behaviours inside such a sphere, where general relativity theory and the Schwarzschild solution are only one framework from which to look at this issue. In 1916, Even Einstein predicted that one needed to unify gravity with some quantum gravity theory to understand gravity even better, or in his own words: "*Because of the intra-atomic movement of electrons, the atom must radiate not only electromagnetic but also gravitational energy, if only in minute amounts. Since, in reality, this cannot be the case in nature, then it appears that the quantum theory must modify not only Maxwell's electrodynamics but also the new theory of gravitation.*" So, our point is that much could still be unsolved. Therefore one should leave some room for scientific speculation around these topics, particularly inside a Hubble sphere that is identical to a Schwarzschild sphere with a mass density one gets from the Hubble constant in the Friedmann equation.

The Hubble sphere circumference frequency would be expected to be only approximately $f \approx \frac{2\pi R_h}{c} \approx \frac{\Theta}{c} \approx 3.61 \times 10^{-19}$ Hz. This calculation would perhaps put a lower limit on the frequency inside our Hubble sphere, similar to the assumptions by many physicists that the Planck frequency $f_p = \frac{c}{l_p}$ would be the upper limit on the frequency, even if that phenomenon has been observed. Several indirectly observed effect?s such as gravity itself, point in that direction according to some papers, [28, 29].

4 Conclusion

We have speculatively suggested that the diameter of the inflated universe hypothetically could be directly related to the circumference of the Hubble sphere since they are so close in value. However, we naturally do not exclude the possibility that this similarity is a pure coincidence. This fact should be carefully investigated before any premature conclusions are made. Our hypothesis could have implications on the interpretations of some suggested minimum acceleration models that have been linked to the radius (or diameter) of the inflatable universe. Also, we have speculated that the Hubble circumference could put a lower limit on possible electromagnetic frequencies inside the Hubble sphere where we live. We hope more researchers will investigate these possibilities to verify or reject these hypotheses based on observations or reasoning.

5 Declaration

The authors have no relevant financial or non-financial interests to disclose.

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