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The 14.6 Billion Age of the Universe in Black Hole $R_{H_t} = ct$ Cosmology versus 13.8 Billon Years in Λ-CDM Cosmology, Dose It Explain the Early Galaxy Formation Problem?

Espen Gaarder Haug[1,2]

[1]Tempus Gravitational Laboratory, Ås, Norway
[2]Norwegian University of Life Sciences, Ås, Norway
Email: espenhaug@mac.com

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Abstract

Haug and Tatum have demonstrated that within certain black-hole $R_{H_t} = ct$ cosmological models, the predicted age of the universe is approximately 14.6 billion years, specifically $t_0 = 14622028851 \pm 421876$ years. This suggests that the universe is about 800 million years older than predicted by the standard Λ-CDM model. One might therefore reasonably consider that this additional age could potentially account for the early galaxy formation observed by the James Webb Space Telescope. However, in this article, we demonstrate that the situation may be more complex than it initially appears. Recent observations have identified bright galaxies at a redshift of $z = 14.32$, corresponding to only about 300 million years after the Big Bang according to the Λ-CDM model. In contrast, within the Haug-Tatum model—despite the universe's greater age of 14.6 billion years—a cosmological redshift of $z = 14.32$ corresponds to merely 62 million years after the universe's origin. Nonetheless, the Haug-Tatum model has two distinct variants, and in one of these, a redshift of $z = 14.32$ corresponds instead to 953 million years after the beginning of the universe. We will explore and discuss these differences further in this note. We will also suggest how a steady state black hole model can solve the early galaxy problem.

Keywords

Black Holes, Early Galaxy Formation Problem, Steady State Cosmology, Escape Velocity, Universe Density

1. Introduction

The Haug and Tatum [1] cosmological model is rooted in the $R_{H_t} = ct$ principle, that is a black hole expanding at the speed of light, but at no time faster or slower than that. In addition, their model heavily relays on that the CMB temperature can be predicted by the equation:

$$T_t = \frac{\hbar c}{k_b 4\pi \sqrt{R_{H_t} 2 l_p}} \tag{1}$$

This equation was first heuristically suggested by Tatum *et al.* [2]. Haug and Wojnow [3] [4] have demonstrated that one can derive this CMB temperature from the Stefan-Boltzmann law. Furthermore, Haug and Tatum have shown that the same formula can be obtained using a geometric mean approach [5]. Haug [6] has demonstrated that the CMB temperature can be expressed simply as:

$$T_{cmb,t} = \sqrt{T_{Haw,max} T_{Haw,min}} \tag{2}$$

where $T_{Haw,max} = \hbar \frac{c}{8\pi l_p} \frac{1}{k_b}$ which is the Hawking temperature off a Planck mass black hole and $T_{Haw,min} = \hbar \frac{c}{4\pi R_{H_t}} \frac{1}{k_b}$ is the Hawking temperature of the whole black hole Hubble sphere.

Based on observations, there appears to be a consensus that the relationship between the CMB temperature and cosmological redshift is given by (see [7]-[9]):

$$T_t = T_0 (1+z) \tag{3}$$

For the Haug and Tatum [10] model to be consistent with this, it must have a cosmological redshift equal to:

$$z = \frac{T_t}{T_0} - 1 = \sqrt{\frac{R_{H_0}}{R_{H_t}}} - 1 = \sqrt{\frac{t_0}{t}} - 1 \tag{4}$$

Solve for the cosmological time t, which is the time since the beginning of the universe. This gives:

$$t = \frac{t_0}{(1+z)^2} \tag{5}$$

We can now check out the time to early galaxies formed at any stage of the universe if we know their cosmological redshift. We will look at this in the next section.

2. Comparison with Observations, the Early Galaxy Formation Problem

Carniani *et al.* [11] discuss well-formed galaxies observed at $z = 14.32^{+0.08}_{-0.2}$ and claims that:

This discovery proves that luminous galaxies were already in place 300 million years after the Big Bang.

The "300 million years after the Big Bang" figure is based on calculations from the Λ-CDM model. In the model described above, the universe is approximately 14.6 billion years old (see Tatum and Haug [12]). One might be tempted to claim that this galaxy was already in place about 300 + 800 million years—that is, 1.1 billion years—after the beginning of the universe in the Haug and Tatum model. However, this would not be correct, as the relationship between cosmic epoch and cosmological redshift differs in the Haug-Tatum model compared to the Λ-CDM model. The time at which this galaxy formed in the cosmological model proposed by Haug and Tatum can be determined from Equation (5); we then obtain:

$$t = \frac{t_0}{(1+z)^2} = \frac{14622028851}{(1+14.32)^2} \approx 62300000 \text{ years} \tag{6}$$

So that means, in the Haug-Tatum model, such a galaxy was already in place about 62 million years after the start of the universe. This does not seem to solve the early galaxy problem directly, nor does it seem to support the Haug-Tatum model.

That said, there could still be uncertainty regarding the exact value of the redshift, despite the reported standard deviation. Secondly, Haug and Tatum [1] have also suggested a model in which one has:

$$z = \frac{T_0}{T_t}(1+z) = \frac{R_{H_0}}{R_{H_t}} - 1 = \frac{t_0}{t_t} - 1 \tag{7}$$

and solved for t we get:

$$t = \frac{t_0}{1+z} \tag{8}$$

This version of the Haug and Tatum cosmology model gives the same predicted 14.6 billion years of the universe, but the now the age of a $z = 14.32$ galaxy is

$$t = \frac{t_0}{1+z} = \frac{t_0}{1+14.32} \approx 954440000 \text{ years} \tag{9}$$

That is such a galaxy observed at such a redshift existed 954 million years after the beginning of the universe. However, in this case the $R_{H_t} = ct$ black hole model is only consistent with $T_t = T_0 (1+z)^{\frac{1}{2}}$ and not with the observational confirmed $T_t = T_0 (1+z)$. Also the Melia [13]-[15] $R_{H_t} = ct$ model should be consistent with this age of the universe (14.6 billion) and that a $z = 14.32$ galaxy already existed 950 million years ago.

Table 1 presents the estimated cosmic time at which these mature galaxies must have existed after the beginning of the universe, according to three models: the two Haug-Tatum $R_{H_t} = ct$ models and the Λ-CDM model. For the Λ-CDM model, we calculated the cosmic time using its standard formulation.

$$t_0 = H_0^{-1} \int_0^{\infty} \frac{1}{(1+z')\sqrt{\Omega_m (1+z')^3 + \Omega_\Lambda}} \tag{10}$$

And the time t, which represents how many years after the Big Bang the redshift value z of interest is reached, is given by:

$$t = H_0^{-1} \int_z^{\infty} \frac{1}{(1+z')\sqrt{\Omega_m (1+z')^3 + \Omega_\Lambda}} \tag{11}$$

Table 1. The table shows recent observations of well-formed galaxies at very high cosmological redshift. As we can see, only the Haug-Tatum-2 model seems to be consistent with that it takes many hundred million years for such galaxies to form. However, the Haug-Tatum-2 model is only consistent with $T_t = T_0(1+z)^{\frac{1}{2}}$ so also this model has issues. It seems like none of these models has a definite solution to the early galaxy formation problem if we can trust the "observations", something we will discuss in the next section.

		Λ-CDM	Haug Taum-1	Haug Tatum-2
Age of universe in billions of years:		13.79	14.62	14.62
Galaxy:	**Observed-estimated:**	**Λ-CDM**	**Haug Taum-1**	**Haug Tatum-2**
JADES-GS-z14-0	$z = 14.32^{+0.08}_{-0.2}$ (See [11])	$t \approx 287$ million	$t \approx 62$ million	$t \approx 950$
JADES-GS-z14-1	$z = 13.90 \pm 0.17$ (See [11])	$t \approx 322$ million	$t \approx 66$ million	$t \approx 981$ million
JADES-GS-z13-1-LA	$z \approx 13$ (See [16])	$t \approx 329$ million	$t \approx 74.5$ million	$t \approx 1043$ million

As input, we have used the values reported by the Particle Data Group (PDG)[1]: $H_0 = 67.4$ km/s/Mpc, $\Omega_\Lambda = \frac{\rho_\Lambda}{\rho_{cr}} = 0.685$, and $\Omega_m = \Omega_c + \Omega_b = 0.315$, where $\Omega_c = \frac{\rho_c}{\rho_{cr}}$ denotes the cold dark matter density parameter, $\Omega_b = \frac{\rho_b}{\rho_{cr}}$ the baryon density parameter, and $\Omega_\Lambda = \frac{\rho_\Lambda}{\rho_{cr}}$ the dark energy density parameter and H_0 the Hubble parameter now. These values calculated for **Table 1** align well with those reported by Carniani *et al.* [11] for the galaxy JADES-GS-z14-0, found at $z = 14.32^{+0.08}_{-0.2}$, and JADES-GS-z14-1, found at $z = 13.90 \pm 0.17$, as well as JADES-GS-z13-1-LA, found at $z \approx 13$; see Witstok *et al.* [16].

For the Haug-Tatum model, we have used $H_0 \approx 66.9$ km/s/Mpc, as this is the value obtained by fitting their model to the full distance ladder of Type Ia supernovae, as well as to the CMB temperature; see [1] [17]. The difference between the H_0 used for the Λ-CDM model and the one used for the Haug-Tatum model is so small that it cannot account for the large differences in the models' outputs. Instead, it is the model assumptions and the models themselves that lead to these substantial differences in the estimated ages of these galaxies.

As evident from the table, only the Haug-Tatum cosmological model-2 appears to be consistent with a potential explanation of the early galaxy formation problem. However, this model is not compatible with the observed $T_t = (1+z)$, but only with $T_t = (1+z)^{\frac{1}{2}}$, and thus also faces a significant challenge. Alternatively galaxies are created and mature much faster than previously assumed. Possible resolutions to the early galaxy formation problem will be discussed in more detail in the section below.

3. Discussion and the Possible Solution: Steady State Black Hole $R_{H_t} = ct$ Cosmology

We have demonstrated that the Haug and Tatum model, which is consistent with

[1] https://pdg.lbl.gov/2023/reviews/rpp2023-rev-astrophysical-constants.pdf.

$T_t = (1+z)$, likely does not seem resolve the early galaxy problem, but this should naturally be investigated further as even the so called observed z values could have something not understood with them yet. Another alternative is that galaxies are forming and developing much faster than assumed.

The alternative black hole cosmological model with $t = \frac{t_0}{1+z}$ appears to possibly explain the early galaxy formation problem as galaxies observed at observed redshifts $z \approx 13$ to $z \approx 14$ are according to this model almost a billion years old. Still this version of the Haug and Tatum model is not consistent with $T_t = (1+z)$ but only with $T_t = (1+z)^{\frac{1}{2}}$ that do not seem to be supported by observations.

However, I will suggest a different hypothesis here. I conjecture that we indeed live in a steady-state black hole universe. This is not something I came up with recently after the recent JWST observations; this is one of multiple views I have been investigating for years, see Haug [18]. That is, there was never a beginning for the universe, there was no Big Bang and the universe has always existed and will always exist. The idea of a steady-state universe goes back thousands of years, or at least to Democritus and atomism around 500 B.C. That the universe was steady state was the consensus even in the years after Einstein [19] published his general relativity theory. The cosmological constant he initially inserted into his field equation in 1917 to make the model compatible with a steady-state universe, see [20].

Anyway, here we suggest a black hole steady state $R_{H_t} = ct$ cosmology. Consequently, one should expect to observe mature galaxies at any cosmological redshift. Thus, we anticipate that as telescopes become increasingly advanced, such mature galaxies will continue to be observed for even much higher observed redshifts than $z = 14$. This scenario is consistent with the recently proposed Carnot Engine black hole model by Haug [21]. This model shares multiple components with the Haug and Tatum model, as it relies on the same CMB prediction formula, essentially relying on the geometric mean approach. However the Carnot engine black hole model is the first model that gives a full and deeper explanation for why the CMB temperature $T_{cmb} = \sqrt{T_{max} T_{min,t}} \approx 2.725\ \text{K}$ must be a geometric mean rather than for example an arithmetic mean. Here $T_{max} = \frac{\hbar c}{k_b 8\pi l_p}$ is the Hawking [22] temperature of the Planck mass black hole and $T_{min,t} = \frac{\hbar c}{k_b 4\pi R_{H_t}}$ is the Hawking temperature of the Hubble sphere, see the paper above. So Haug and Tatum [5] were right in their intuition and reasoning that the CMB temperature is linked to a geometric mean temperature, but it is first when one considers an extremal black hole one, gets consistency with the ideal Carnot engine principle which requires zero entropy change. However, such a view is not consistent with Schwarzschild black holes, but rather is rooted in the Extremal Universe model of Haug [23], which aligns with the extremal solutions of Reissner-Nordström [24]

[25], Kerr [26], Kerr-Newman [27] [28], and the Haug-Spavieri [29] metric that is fully consistent with zero entropy change $dS = 0$ in the Hubble sphere overall, thus is due to two types of entropy working in the opposite direction, that again are linked to two forces acting in the opposite direction. Hawking *et al.* [30] already in 1995 pointed out extremal RN black holes have zero entropy, but it should rather be interpreted as zero entropy change in our view. Such a black hole cosmology is consistent with the following cosmological model derived from Einstein's 1916 field equation (see [23]):

$$H_t^2 = \frac{8\pi G\rho_t - \Lambda_t c^2}{3} \tag{12}$$

where $\Lambda_t = 3\frac{H_t^2}{c^2}$ is the cosmological constant, and the parameters follow the $R_{H_t} = ct$ principle. What is remarkable about this model is that the cosmological constant arises automatically from the metric solutions based on the Einstein 1916 field equation. The Einstein 1916 field equation itself has no cosmological constant inserted. Equation (12) should also not be confused with the Friedemann [31] equation; despite some similarities, it yields rather different predictions for certain aspects of the universe.

Despite being an $R_{H_t} = ct$ model, there is no expansion of the black hole or beginning of the universe in such a steady-state universe. The $R_{H_t} = ct$ principle simply describes what happens from an observational perspective when receiving signals traveling at speed c from a certain distance (z). This is directly connected to the fact that the maximum speed for both gravity and light is the speed of light. It is a steady-state black hole cosmological model, predicting that the universe has always existed and will always continue to exist. This model also raises the question of the nature of such a black hole. We conjecture that either we live inside such a black hole or, more likely, that every point in the universe has a Hubble radius beyond which it cannot receive information. Thus, the center of the universe is everywhere, and every point possesses its own Hubble radius.

We summarize the possibilities discussed below:

- If the Haug and Tatum model consistent with $t = \frac{t_0}{(1+z)^2}$ and $T_t = T_0(1+z)$ is correct, then either the reported cosmological redshifts at great distances must be incorrect, or galaxies are forming much more rapidly than previously assumed. A $z = 14.32$ galaxy must have already existed just 62 million years after the beginning of the universe.
- If the alternative Haug and Tatum model consistent with $t = \frac{t_0}{1+z}$ and $T_t = T_0(1+z)^{\frac{1}{2}}$ is correct, then there must be some misunderstanding regarding the "observed" $T_t = T_0(1+z)$ relation. This particular variant of the HTC model predicts that a $z = 14.32$ galaxy existed about 950 million years after the beginning of the universe.
- Our conjecture in this paper is that there was no beginning of the universe, no

Big Bang, and that there is no expanding universe, nor any expanding black hole universe. Rather, the universe is—as was assumed for hundreds of years—a steady-state universe. This leads to the prediction that we will continue to find well-formed galaxies at even higher cosmological redshifts in the future. The universe is likely either a physical extremal black hole or an "illusionary" black hole, where every point possesses its own Hubble radius. The Hubble radius simply represents an information horizon: every point in the universe cannot receive information from beyond its own Hubble radius. This is consistent with the Extremal Universe model of Haug [23], as well as the Haug-Spavieri Universe [32], which are essentially the same cosmological model derived from multiple different metric solutions to Einstein's 1916 field equation, rather than from his extended 1917 field equation.

So all these, as well as other cosmological models such as, for example, the $R_{H_t} = ct$ model of Melia, should be investigated further. One should also carefully investigate the observations further, bearing in mind what is truly observed and what is interpreted through a cosmological model lens.

The steady state model can also explain observed violations of the cosmological principle (CP). The cosmological principle states that our Universe is both homogeneous and isotropic on large scales. Lopez *et al.* [33] has pointed out that such findings as the Big Ring and other observed mega structures possible means the cosmological principle is violated. Furthermore, a steady-state black hole model, where the universe has always existed and always will exist, should be consistent with the observed megastructures. In particular, if the event horizon (the Hubble radius) is just an information horizon for every point in the universe.

4. The Universe as a Steady State Physical Black Hole

One possibility is that our universe is a steady state black hole universe. That is the whole Hubble sphere is then a non-expanding black hole. The idea of the Hubble sphere being a black hole goes at least back to Pathria [34] in 1972 and black hole cosmology is actively discussed to this day see for example [35]-[45]. Shamir [46] based on recent data from JWST suggests the possibility that our Universe could be the interior of black hole in a parent universe. This we have illustrated in **Figure 1** where the orange sphere is our Hubble sphere that is a rotating extremal Kerr black hole.

Based on large-scale mega structures and the discovery of well-formed galaxies very close to the expected age of the universe, the Hubble sphere could represent a steady-state black hole universe. In such a scenario, there is no finite age of the universe—the age is infinite. What we perceive as the "age of the universe" is simply the time it takes for light to travel from the radius of the universe to its center (or in the opposite direction). Such a steady-state physical black hole universe would likely have to be an extremal black hole, and not a Schwarzschild black hole, since in an extremal black hole there exists an opposing force counteracting gravity, preventing matter and energy from being drawn into the central singularity. An extremal black hole is also in equilibrium, possessing zero net entropy, as first pointed out by Hawking [30]. Zero net entropy, however, implies the presence of a force acting against entropy increase. The universe could, therefore, be conceptualized as a black hole Carnot engine, as recently proposed by Haug [21].

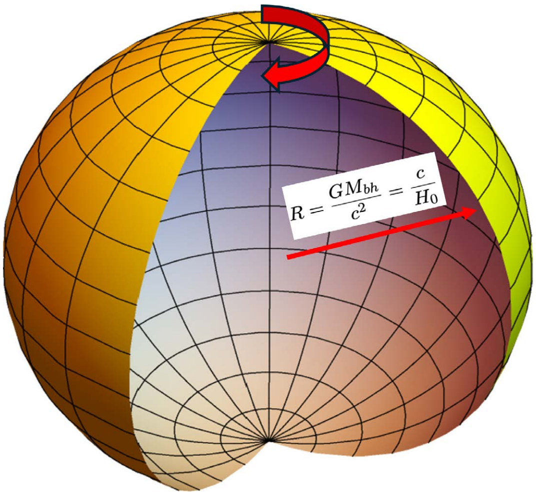

Figure 1. The figure illustrates that the universe is a physical extremal Kerr black hole that is spinning. It is possible that photons are traveling around the circumference of the black hole along its surface, contributing to the spin. Matter inside is also likely affected by the spinning black hole Hubble sphere.

An extremal Reissner-Nordström black hole could also serve as a model for such a steady-state universe. It is not an accreting black hole; instead, it maintains a perfect equilibrium between two forces. One of these forces is clearly gravity, while the opposing force, which we might term as an electrostatic force, does not necessarily have to be electrostatic in the traditional sense. This counteracting force could even stem from rotation, as in an extremal Kerr black hole, or from a relativistic effect not accounted for in the Schwarzschild metric; see Haug and Spavieri [29].

There are challenges also with such a steady-state black hole theory, or indeed with any physical black hole theory. If we live inside a physical black hole but not at its center, we would expect to observe significant asymmetries in the universe. For example, if we were located near the inner surface of the Hubble sphere, we would be able to see much farther into the universe in some directions than in others.

There is, however, an alternative: a slightly less rigid concept of black holes, which we will refer to as illusionary black holes. An illusionary black hole possesses the mathematical properties of a real black hole but is not a physical black hole in the traditional sense. In this framework, the event horizon is simply an information horizon, and every point in the universe has such an event horizon—a concept we will explore further in the next section.

5. Why the Universe Could Be Infinite in Space and Time, Yet Still Contain Illusionary Black Holes of Hubble Size from Every Point in Space

Assume the universe is infinite in space and time. That is a classical steady-state universe. Assume further that the density over large cosmic scales is uniform, inside smaller segments the density can naturally vary considerably. The argument we will present here is not dependent on what exactly the density is, as long as the density is above zero. What is important is that over large cosmic scales, the density is quite uniform across different large-scale segments. A black hole in its most general form is defined by having an escape velocity equal to the speed of light, which in a Schwarzschild metric is given by:

$$v_e = c = \sqrt{\frac{2GM}{R}} \tag{13}$$

Whereas in an extremal black hole, it is given by[2]:

$$v_e = c = \sqrt{\frac{GM}{R}} \tag{14}$$

Next, we re-write this as:

$$c = \sqrt{\frac{GM}{R}}$$

$$c = \sqrt{\frac{4G\dfrac{M}{\frac{4}{3}\pi R^3}\pi R^3}{3R}}$$

$$c = \sqrt{\frac{4\pi G\rho R^2}{3}}$$

$$c^2 = \frac{4\pi G\rho R^2}{3}$$

$$R = \sqrt{\frac{3c^2}{4\pi G\rho}} \tag{15}$$

So, any infinite size universe with "uniform" density > 0 will have an event horizon from every point in the universe. These create illusory black holes in the steady-state universe, where the event horizon given by Equation (15) likely just act as an information horizon. Each point in the universe cannot receive information from beyond a radius of $R = \sqrt{\frac{3c^2}{4\pi G\rho}}$. The extremal solutions of Reissner-Nordström, Kerr, Kerr-Newman, and the minimal solution of Haug-Spavieri have a total density of:

$$\rho = \frac{3\pi H_0^2}{4\pi G} \tag{16}$$

[2]That is only when $v_e = c$, when $v_e < c$ we have $v_e = c = \sqrt{\frac{GM}{R} - \frac{G^2M^2}{c^4R^2}}$.

That is twice the critical Friedmann density: $\rho_{cr} = \frac{3\pi H_0^2}{8\pi G}$. When we plug this density into the event horizon formula above, we get:

$$R = \sqrt{\frac{3c^2}{4\pi G\rho}} = \frac{c}{H_0} \tag{17}$$

That is, each point in the steady-state universe with the density of the universe equal to $\rho = \frac{3\pi H_0^2}{4\pi G}$ must have an event horizon equal to the Hubble radius. **Figure 2** illustrates how a point in the universe has such a Hubble sphere around it.

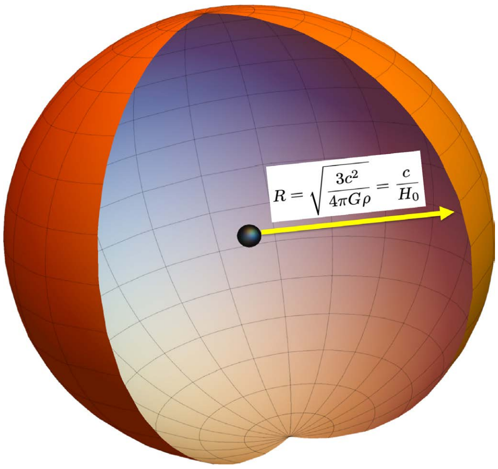

Figure 2. The figure illustrates that a point in the universe with an energy density different from zero has an information horizon around it, equal to the Hubble radius.

Figure 3 illustrates a series of points in the universe, all with an information event horizon equal to the Hubble radius. A given point cannot receive information from beyond its Hubble radius. Points in the universe that are closer to each other than twice the Hubble radius, $2R_H = \frac{2c}{H_0}$, will then have overlapping areas. The universe is thus an infinite number of Hubble spheres. The reason matter is not drawn together into a central singularity is quite clear: as the universe is infinite, each Hubble sphere, which in isolation would form a black hole, experiences counteracting gravitational forces from the surrounding matter. The universe is then in gravitational equilibrium over waste cosmic distances and is for this reason also spatially flat. In addition, if we are working with extremal black holes, there are additional forces counteracting gravity, such as electrostatic forces. These will hinder matter and energy from ending up in a central singularity.

One could critisize this view, as the black hole spherical metric solutions to Einstein's field equations are generally vacuum solutions. However, the extremal solution of the Reissner-Nordström metric, as well as the Haug-Spavieri metric, seems to impose a constraint on the mass density that suggests we can apply the vacuum exterior solution even inside the black hole. The constraints on the mass distribution imply that it would effectively be identical to a vacuum solution. This is beyond the scope of this paper, but in short, this is not the case for the Schwarzschild metric, as all matter and energy would collapse into the central singularity. However, in the extremal solution, this does not occur.

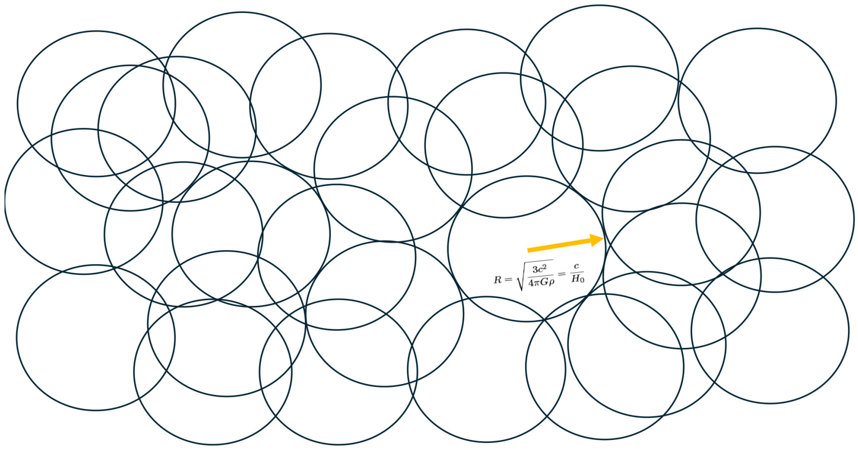

Figure 3. The figure illustrates that each point in the universe could have a Hubble radius. The Hubble radius is then simply an information horizon. Some Hubble spheres overlap and share space, while others do not overlap. Any two points closer to another than $2R_H$ will have overlapping areas.

6. Conclusions

The Haug and Tatum $R_{H_t} = ct$ model, consistent with $T_t = T_0(1+z)$, gives a predicted age of the universe of approximately 14.6 billion years, which is 800 million years longer than the Λ-CDM model estimate of 13.8 billion years. In the Λ-CDM model, one has observed well-formed galaxies that existed 300 million years after the Big Bang, as analysed through the mathematical lens of the Λ-CDM model. Well-formed galaxies are not supposed to form so early. One might think the Haug and Tatum model solves this, as it has 800 million more years to account for, but despite this, a galaxy at $z = 14.32$ existed already only 62 million years after the start of the universe in this model, so it does not solve the early galaxy formation problem, at least not in the way one could initially expect by only looking at the predicted age of the universe: 14.6 billion years.

Haug and Tatum have, in a variant of their $R_{H_t} = ct$ model, consistency with $T_t = T_0(1+z)^{\frac{1}{2}}$; then a galaxy at $z = 14.32$ existed 950 million years after the start of the universe, so this could solve the early galaxy formation problem. But then the observed principle $T_t = T_0(1+z)$ cannot be correct, so this also does not seem to be right, but should be investigated further.

We propose a new explanation for the early galaxy formation problem, namely that we are living in a steady-state black hole universe that has always existed and always will exist. Either we are living inside such a physical steady-state black hole, or, alternatively, every point in the universe has an information limitation radius equal to $R=\sqrt{\frac{3c^2}{4\pi G\rho}}=\frac{c}{H_0}$. Both of these views can likely fit with the extremal universe [23]. Thus, the universe has a center everywhere, with a corresponding Hubble radius. The Hubble radius is then simply an information horizon radius: no information beyond such a point can reach the observer at a given location. From this perspective, we should observe well-formed mature galaxies at any observed cosmological redshift, even, for example, above $z=20$ and even above $z=100$.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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