Determining the Radius of the Observable Universe Using a Time-Scaled 3-Sphere Model of the Universe

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ABSTRACT

Observation: Treating the observable universe as the surface volume of a 3-sphere allows us to produce a simple equation for the radius of the observable universe. By taking the ratio of the standard three dimensional volumes for the observable universe to the Hubble volume, and setting it equal to the ratio of the corresponding volumes derived using the equations for the surface volume of a 3-sphere, we can solve for the radius of the observable universe. We find that this radius to be the cube root of 12 pi, times the Hubble radius, or 46.27 billion light years, which matches the accepted figures. The volume of the observable universe is shown to be larger than the Hubble volume by a factor of 12 pi. This gives us a simple expression for the radius and volume of the observable universe, derived from the geometry of a 3-sphere.

Explanation: But the whole universe is vastly larger than the observable, and the observable universe is not a 3-sphere, forcing us to explain how this artificial 3-sphere, clearly smaller than what the true 3-sphere would be, can show such behavior. We use the argument from another hyperverse paper, on quantum time, that the relative increase in the unit of quantum time cancels the rapidly increasing growth rate of the whole hyperverse, resulting in a constant, 2c radial expansion rate. This allows the observable universe to be treated, in many respects, as a stand-alone hyperverse, a time-scaled version of the whole. This time-scaling gives the observable universe many of the properties of a 3-sphere.

Subject headings: hyperverse; radial expansion; 3-sphere; Hubble radius

1. Introduction

The universe may be the surface volume of a 3-sphere. Examining this possibility, we reported in [1] a peculiar observation, that a 3-sphere whose surface volume matched the volume of our three dimensional, observable universe, had a radius of about 27.6 billion light years, meaning it would be expanding at twice the speed of light, or 2c. This observation lead to other papers discussing this 'hyperverse model' [2, 3, 4, 5, 7].

The whole universe is considerably larger than the observable, and the hyperverse model supports this, with the prediction that the whole is larger than the observable by a factor of about 4.344×10^{243} times [5]. Given it is both larger than the observable, and the same age, we find that the whole is expanding into the fourth dimension at a rate much greater than 2c, and this rate is accelerating.

This left the issue of just why this 'observable hyperverse' is expanding at 2c. That issue was addressed in [5], where we showed that the unit of quantum time is not constant, but varies with expansion and age. We showed that the ratio of the unit of quantum time for the observable universe, to the unit of quantum time for the whole universe, is increasing at the same rate as the whole universe, canceling it, and giving us the constant expansion rate of 2c. This results in the observable universe being, in essence, a time-scaled version of the whole.

This time-scaling of the observable universe allows us to treat the observable universe, in many ways, as a stand-alone hyperverse, or surface of a 3-sphere.

In this paper, we use the 3-sphere concept to produce a simple way to calculate the radius of the observable universe, further supporting the proposition that the observable universe is a time-scaled hyperverse.

2. Calculating the Radius of the Observable Universe Using the Hyperverse Model

The general formula of a 3D volume of a sphere is $\frac{4}{3}\pi r^3$.

The surface volume of a 3-sphere is given by the general formula: $2\pi^2 R^3$.

We will use the convention that a small 'r' represents the radius within 3D space, and a large 'R' represents the hyper-radius of a 3-sphere.

There is a direct proportional relation between the radii. Setting the surface volume of a 3-sphere equal to the 3D volume of a standard sphere as in equation (1), we see in equation (3) that the radius of the 3-sphere, a hyper-radius to us, is directly proportional to the radius, small r, of a standard 2-sphere.

$$2\pi^2 R^3 = \frac{4}{3}\pi r^3 \tag{1}$$

$$R^3 = \frac{\frac{4}{3}\pi r^3}{2\pi^2} = \frac{2}{3\pi} r^3 \tag{2}$$

$$R = \sqrt[3]{\frac{2}{3\pi}} r \tag{3}$$

Therefore, the ratio of the volume of the observable universe to the Hubble volume, is the same as their ratios if they were the surface volumes of a 3-sphere:

$$\frac{v_o}{v_{ct}} = \frac{V_H}{V_{ct}} \tag{4}$$

where

$$v_o = \frac{4}{3}\pi r_o^3 = \text{the volume of the observable universe} \tag{5}$$

$$v_{ct} = \frac{4}{3}\pi r_{ct}^3 = \text{the volume of the Hubble sphere} \tag{6}$$

$$V_H = 2\pi^2 R_H^3 = \text{the hyper-volume of an "observable hyperverse" with radius } R_H \tag{7}$$

$$V_{ct} = 2\pi^2 R_{ct}^3 = \text{the hyper-volume matching the volume of the Hubble sphere} \tag{8}$$

We can place our volumes in the ratio equation:

$$\frac{\frac{4}{3}\pi r_o^3}{\frac{4}{3}\pi r_{ct}^3} = \frac{2\pi^2 R_H^3}{2\pi^2 R_{ct}^3} \tag{9}$$

and cancel out the appropriate terms to see that the volume ratio reduces to a ratio of radii:

$$\frac{r_o^3}{r_{ct}^3} = \frac{R_H^3}{R_{ct}^3} \tag{10}$$

The Hubble radius is defined as:

$$r_{ct} = ct \tag{11}$$

The radius of the observable hyperverse, R_H, is expanding at twice the speed of light, or 2c, so that:

$$R_H = 2ct \tag{12}$$

To determine R_{ct} we find the 3-sphere whose surface volume equals the Hubble volume, and solve for R_{ct}

We set the 3-sphere's surface volume equal to the Hubble volume:

$$2\pi^2 R_{ct}^3 = \frac{4}{3}\pi r_{ct}^3 \tag{13}$$

rearrange and solve for R_{ct}:

$$R_{ct} = \sqrt[3]{\frac{2}{3\pi}} r_{ct} \tag{14}$$

since $r_{ct} = ct$, we have:

$$R_{ct} = \sqrt[3]{\frac{2}{3\pi}} ct \tag{15}$$

We can rearrange equation (10) to solve for r_{ct}^3:

$$\frac{r_o^3}{r_{ct}^3} = \frac{R_H^3}{R_{ct}^3} \Rightarrow r_o^3 = \frac{R_H^3}{R_{ct}^3} r_{ct}^3 \tag{16}$$

Substitute our values for r_{ct}, R_H, and R_{ct} into the ratio equation:

$$r_o^3 = \frac{(2ct)^3}{\left(\sqrt[3]{\frac{2}{3\pi}} ct\right)^3} (ct)^3 \tag{17}$$

We find the key equation of this paper, that r_o, the radius of the observable universe, is:

$$r_o = (12\pi)^{\frac{1}{3}} (ct) \tag{18}$$

Given an age of 13.8 billion years, or $4.354\,948\,8 \times 10^{17}$ s, the radius of the observable universe is

$$(12\pi)^{\frac{1}{3}} \left(2.99792458 \times 10^{8}\,\mathrm{m\,s^{-1}}\right) \left(4.354\,948\,8 \times 10^{17}\,\mathrm{s}\right) = 4.377\,714\,779\,720\,536\,265\,2 \times 10^{26}\,\mathrm{m} \tag{19}$$

In light years, this is:

$$\frac{4.377\,714\,779\,720\,536\,265\,2 \times 10^{26}\,\mathrm{m}}{9.4605284 \times 10^{15}\,\mathrm{m}} = 4.627\,347\,009\,201\,448\,267\,1 \times 10^{10} \tag{20}$$

We calculate the radius of the observable universe to be 46.27 billion light years, which is in agreement with the commonly accepted value [6].

We can take our equation for the radius of the observable universe, (18), and substitute in our value of $\frac{R_H}{2c}$ [1] for the age of the universe:

$$r_o = (12\pi)^{\frac{1}{3}} ct = (12\pi)^{\frac{1}{3}} (c) \left(\frac{R_H}{2c}\right) = \frac{\sqrt[3]{12\pi}}{2} R_H \tag{21}$$

The volume for the observable universe would be:

$$\frac{4}{3}\pi (r_o)^3 = \frac{4}{3}\pi \left(\frac{\sqrt[3]{12\pi}}{2} R_H\right)^3 = 2\pi^2 R_H^3 \tag{22}$$

We can see that equation (18) is a restatement of our equation for the surface volume of the observable hyperverse, (7).

3. Discussion

In the hyperverse model, the universe is the surface volume of an expanding 3-sphere, undergoing a constant rate of expansion [7]. The hyperverse model produces equations of matter [4] that show that matter is continuously created, starting at the Big Bang, and thus the hyperverse model is not an FRW universe.

We show here that the ratio of the volume and radius of the observable universe, to that of the Hubble volume and radius, is a simple proportion. That is, the volume of the observable universe is larger than the Hubble volume by a factor of 12π, and the radius is radius is larger by the cube root of 12π.

The ratio will stay constant with expansion:

$$\frac{r_o}{r_{ct}} = \frac{(12\pi)^{\frac{1}{3}}\,(ct)}{ct} = \sqrt[3]{12\pi} \tag{23}$$

The relation between the observable radius and the Hubble radius is a geometrical, a consequence of the 2c radial (into the fourth dimension) expansion. This further supports the contention that the universe is the surface of an expanding 3-sphere.

The whole universe is vastly larger than the observable universe, so that the observable is just a tiny portion of the surface of the whole. The observable universe is not curved into a 3-sphere; it is not a literal hyperverse.

But the observable universe acts like a miniature version of the whole hyperverse in many ways. We claim this is due to time scaling [5]. The whole hyperverse is expanding at an extraordinarily high radial velocity, and its expansion rate is accelerating. The unit of our quantum time is also increasing, while the unit of cosmic time, the time we can associate with the whole hyperverse, is shrinking. Their ratio increases at the same rate as the radial velocity of the whole, canceling it, giving us the constant, 2c radial velocity we experience. Each point in space experiences this time scaling, which has the effect of making the observable universe act like a stand-alone hyperverse in many, but not all, respects. Curvature, for instance, is not related to time, and is therefore not affected. We propose that time-scaling is the reason that the observable universe behaves as if it were the surface volume of a stand-alone 3-sphere, or hyperverse, with its own radius and volume.

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