Our universe is inside a black hole; dark energy is gravity

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In absolute space and time, the Schwarzschild metric has a coordinate singularity at the Schwarzschild radius. The coordinate singularity can be transformed away by changing the coordinate system. However, if the developers of our universe used absolute space and time for our coordinate system, then the coordinate singularity at the Schwarzschild radius is a real singularity in our universe. In which case, astronomical observations indicate that our universe is inside a black hole because in absolute space and time: 1) the singularity at radius 0 is repulsive, explaining the big bang, and 2) the singularity at the Schwarzschild radius attracts matter inside the black hole toward the inner surface and adds a gravitational redshift, explaining dark energy and the apparent accelerating expansion of our universe. It is within estimation errors that the inner surface of our black hole is plastered with a single layer of compressed neutrons 4.4×10^{-20} m thick. Many other predictions arise, including that we may live in a bang-bang universe where matter is blasted back and forth between radius 0 and the inner shell, and that event horizon expansion is increasing the size and mass of our universe.

INTRODUCTION

Five phenomena in our universe are: 1) our universe appears to have started with a big bang, 2) our universe appears to be expanding, 3) the expansion appears to be accelerating, 4) our universe appears to be heterogeneous (matter is uniformly distributed), and 5) our universe appears to be isotropic (it looks the same in all directions).

One explanation for all five phenomena is that our universe is inside a black hole.

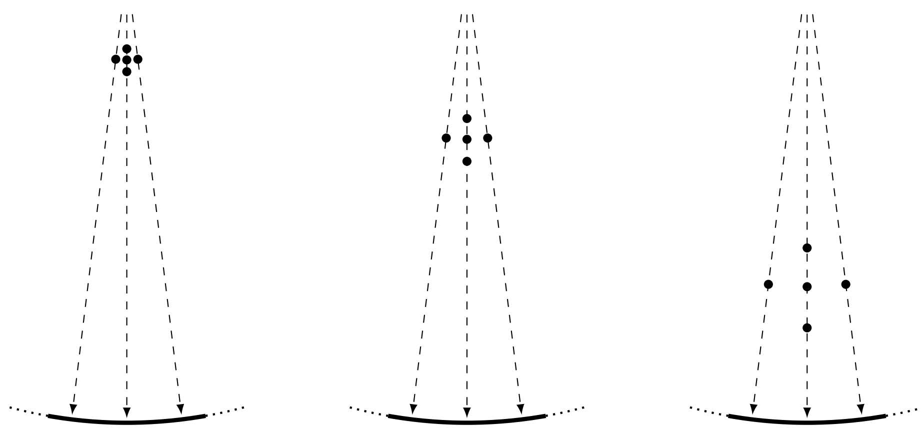

Figure 1: The rough idea: inside a gravitationally attractive spherical shell, particles in free fall expand away from each other. The expansion accelerates as the particles accelerate.

The rough idea (see Figure 1) is that inside a gravitationally attractive spherical shell, particles in free fall expand away from each other. The expansion accelerates as the particles accelerate. The gravitationally attractive shell is the inside surface of a black hole. The dark energy causing the expansion is gravity.

If Figure 1 bothers you because the arrows are pointing toward the inside surface of the black hole and not toward the central singularity at $r = 0$, that point is addressed in the Discussion section at the end of this paper.

Because our universe contains black holes (which might contain smaller universes, which we could call endoverses), I believe that our universe's black hole is contained in an even larger universe (exoverse), and that our exoverse is contained in an even larger exoverse, and so on. This recursively nested hierarchy of black holes comprises the holoverse.

The notion of a holoverse of recursively nested black holes gives us a tool to reason about the physics in our universe. For example, it is probably safe to assume that whatever can happen to the black holes in our universe can happen to our universe's black hole in our exoverse. Using reasoning of this style, we can deduce a bang-bang model of universe formation where matter is blasted back and forth between the inner shell of our black hole and the central singularity at $r = 0$.

The holoverse also gives us some fun things to speculate about. Can we break out of our universe into the surrounding exoverse? Is the missing antimatter in our universe in our endoverses or in our exoverse? Are event horizons the boundaries between matter and antimatter? Is our universe the highest level in the recursion?

STRUCTURE OF A SCHWARZSCHILD BLACK HOLE IN ABSOLUTE SPACE AND TIME

For the purposes of this paper, it is sufficient to approximate a black hole as a Schwarzschild black hole. It is also sufficient to examine only radial motion for both photons and massive particles. We treat as a particle anything that is small compared to the black hole, such as planets, stars, and galaxies. All equations in this paper are written without any assumptions about units, such as setting $c = 1$, so you can use whatever system of units you prefer, such as metric.

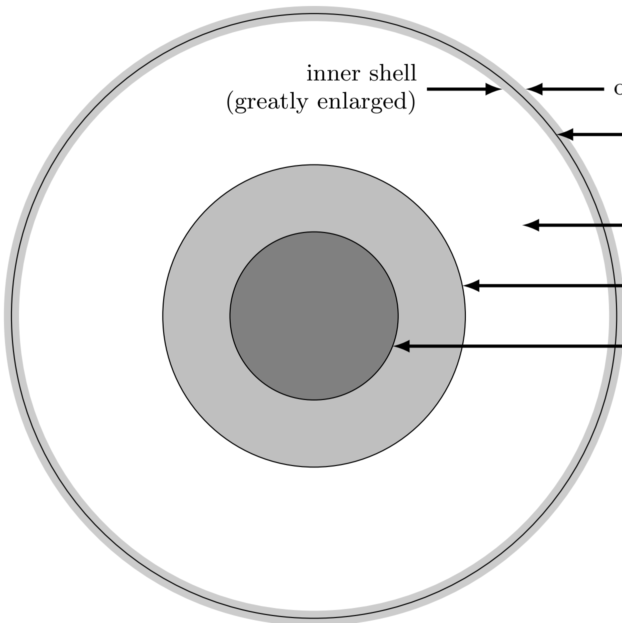

Figure 2: Structure of a Schwarzschild black hole in absolute space and time. M is the mass, K is the gravitational constant, and R_S is the Schwarzschild radius.

The coordinate system we will use is absolute space and time. All of the times, distances, velocities, and accelerations in this paper are absolute. To convert absolute values to proper values, see [6] or [4]. In the context of Schwarzschild black holes, absolute space and time coordinates are often called Schwarzschild coordinates or Boyer-Lindquist coordinates.

Using absolute space and time allows us to use the ordinary three dimensional mechanics of absolute gravity[5][7]. In absolute space and time, space is euclidean and time is indepedent of space, but photons do not travel at a constant velocity; they speed up and slow down.

Using absolute gravity, Schwarzschild black holes have a well defined internal structure (see Figure 2).

The Schwarzschild radius R_S of a black hole is

$$R_S = \frac{2KM}{c^2}. \tag{1}$$

where K is the gravitational constant, M is the mass, and c is the speed of light. Another characteristic of a black hole that we will use is the Schwarzschild time, which is the time it would take for a photon moving at a constant speed c to travel R_S:

$$T_S = \frac{R_S}{c} = \frac{2KM}{c^3} \tag{2}$$

The velocity $\mathbf{v}$ of a radial photon either inside or outside of a black hole is[7]:

$$\mathbf{v} = \pm c \left(1 - \frac{2KM}{c^2 r}\right) \hat{\mathbf{r}}. \tag{3}$$

The $\pm$ sign indicates that a radial photon can be moving either away from (+) or toward ($-$) the event horizon.

The acceleration of a radial particle either inside or outside of a black hole, and moving with velocity $v\hat{\mathbf{r}}$, is[7]:

$$\mathbf{a} = -\frac{KM}{r^2}\left(\left(1-\frac{2KM}{c^2r}\right)-\frac{1}{1-\frac{2KM}{c^2r}}\frac{3v^2}{c^2}\right)\hat{\mathbf{r}}. \tag{4}$$

The inner shell and outer shell are thin layers of compressed matter on either side of the event horizon.

The mantle is the region where the speed of all photons and massive particles is $< c$. The mantle extends from $\frac{1}{2}R_S$ to R_S.

The photocore is the region where the speed of all photons is $\geq c$. The photocore extends from 0 to $\frac{1}{2}R_S$.

The mattercore is the region where all radial massive particles that start free falling with an initial speed of 0 will be accelerated to to superluminal speeds $\geq c$. The mattercore extends from 0 to about $0.278\,R_S$.

THE BIG BANG

In a black hole, the big bang is caused by the rapid acceleration of matter in free fall. A single massive particle can undergo a big bang all by itself if it starts from rest inside the mattercore. The particle will first accelerate to superluminal speeds and then slow down as it enters the gravity well of the inside shell.

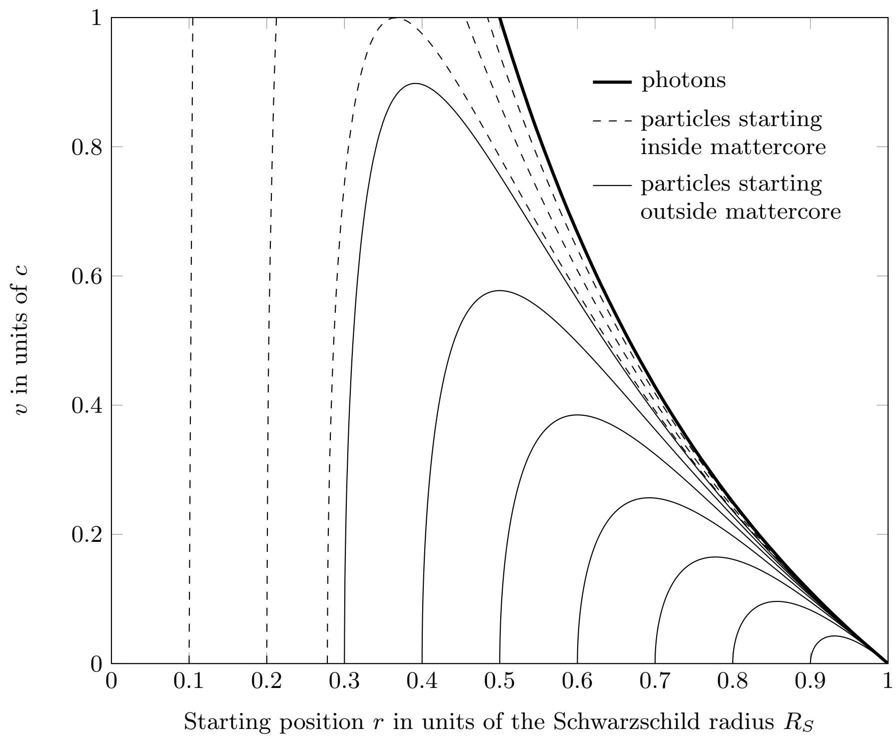

Figure 3: Speed v of massive particles at various positions r as they freefall from rest with initial speed $v = 0$ toward the inner shell at $r = 1$. Note that massive particles starting from rest inside the superluminal mattercore for $r \leq 0.278$ reach speeds $\geq c$. All photons in the superluminal photocore for $r < \frac{1}{2}$ go faster than c. All massive particles and photons slow down so that $v \to 0$ as they approach the inside shell as $r \to 1$.

Figure 3 shows the speeds attained by particles initially at rest at various radii as they free fall toward the inner shell. The superluminal speeds go off the top of the graph, which is capped at c. The speeds were calculated by numerically solving Equation (4).

A HETEROGENEOUS AND ISOTROPIC UNIVERSE

Figure 1 shows the rough idea behind an isotropic universe. The refinements that need to be made to adjust for the gravitational field inside a black hole add nothing to the idea, but are mainly detailed conversions from absolute to proper coordinates, so I will not cover them further here.

We do not need to assume that our universe is heterogeneous if we are inside a black hole because the big bang provides a mechanism to make it heterogeneous. The crossing paths in Figure 4 show how particles initially at rest will bang into each other as they free fall toward the inner shell, forcing interaction and mixing.

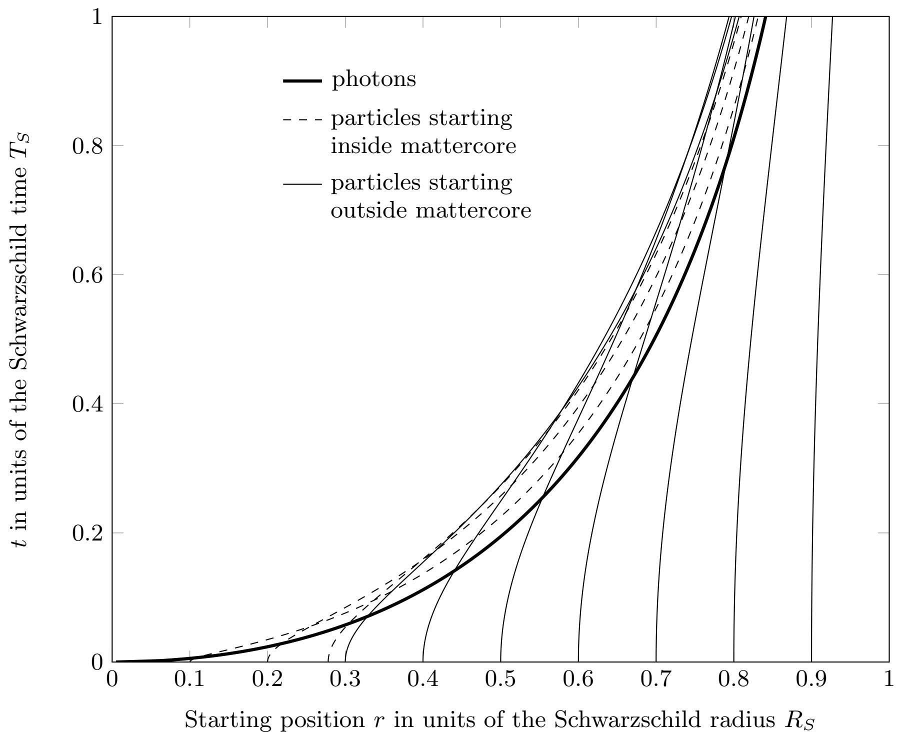

Figure 4: The crossing paths of particles that started at different radii show how the big bang provides a mechanism for interaction and mixing to create a heterogeneous universe

PROPERTIES OF THE INNER SHELL

At best this section is an exercise in informed guessing. There are too many uncertainties to claim any sort of accuracy. Is a Schwarzschild black hole a good approximation to our universe's black hole? What is the total mass of our black hole? What are the effects of unknown physics near the event horizon? Perhaps even worse, I am going to approximate the inner shell as having a fixed thickness and uniform density.

Despite those problems, I think that the estimates turn out to be reasonable. I also think it is interesting that the inner shell could possibly be a single layer of neutrons that gravity has flattened like pancakes.

We start by estimating three numbers: M, the total mass of our black hole; Ω_s, the fraction of the total mass in the inner shell; and σ_s, the average density of the inner shell.

For M, the total mass of our black hole, and Ω_s, the fraction of mass in the inner shell, I have seen estimates that the mass of the observable universe as about 1.5×10^{53} kg and I have seen estimates that the observable universe is anywhere from 5% to 30% of the total mass of the whole universe. Since 1.5×10^{53} is 15% percent of the nice round number 1×10^{54}, I estimate that:

$$M = 1 \times 10^{54}\,\text{kg}, \tag{5}$$

$$\Omega_s = 0.85. \tag{6}$$

For σ_s, the average density of the inner shell, I imagine that the inner shell is extremely dense on the outside surface right next to the event horizon, and less dense on the inside surface. The most dense thing I can think of is a small black hole such as [8], which has a density of about $2 \times 10^{18}\,\mathrm{kg\,m^{-3}}$. I cannot imagine that the inside surface can be any less dense than a neutron star at about $3 \times 10^{17}\,\mathrm{kg\,m^{-3}}$. I have seen estimates that the center of a neutron star has a density of 6 to $8 \times 10^{17}\,\mathrm{kg\,m^{-3}}$, so for σ_s I estimate a middling value of

$$\sigma_s = 7 \times 10^{17}\,\mathrm{kg\,m^{-3}}. \tag{7}$$

Using these estimates, we can calculate three properties of the inner shell: R_S, the Schwarzschild radius; ρ_s, the mass per square meter of the inner shell; and l_s, the thickness of the inner shell:

$$R_S = \frac{2KM}{c^2}, \tag{8}$$

$$\rho_s = \frac{\Omega_s M}{4\pi R_S^2}, \tag{9}$$

$$l_s = \frac{\rho_s}{\sigma_s}. \tag{10}$$

Plugging the estimates from equations (5) to (7) into equations (8) to (10) gives:

$$R_S = 1.5 \times 10^{27}\,\mathrm{m} = 160 \times 10^9\,\mathrm{ly}, \tag{11}$$

$$\rho_s = 0.03\,\mathrm{kg\,m^{-2}}, \tag{12}$$

$$l_s = 4.4 \times 10^{-20}\,\mathrm{m}. \tag{13}$$

To get a feel for the inner shell, we can convert ρ_s from $\mathrm{kg\,m^{-2}}$ to neutrons N per square meter:

$$N = \frac{\rho_s}{\text{mass per neutron}} = \frac{0.03\,\mathrm{kg\,m^{-2}}}{1.7 \times 10^{-27}\,\mathrm{kg}\text{ per neutron}} = 1.8 \times 10^{25}\,\text{neutrons}\,\mathrm{m^{-2}}. \tag{14}$$

If we arrange the neutrons in a one square meter grid, they form a single sparse layer with $\sqrt{N} = 4.2 \times 10^{12}$ neutrons on a side. The spacing between neutrons is about $2.4 \times 10^{-13}\,\mathrm{m}$, which is about 280 times larger than the neutron radius of $0.85 \times 10^{-15}\,\mathrm{m}$.

The total volume of the neutrons is the number of neutrons times the volume of each neutron:

$$1.8 \times 10^{25} \left(\frac{4}{3}\pi(0.85 \times 10^{-15}\,\mathrm{m})^3\right) = 4.6 \times 10^{-20}\,\mathrm{m^3}. \tag{15}$$

Thus our sparse one square meter grid of spherical neutrons could squish down to a solid one square meter shell of flat neutrons with a thickness of about $4.6 \times 10^{-20}\,\mathrm{m}$, which is well within our estimation errors of the thickness of the inner shell from equation (13) of $4.4 \times 10^{-20}\,\mathrm{m}$.

THE HOLOVERSE AND THE BANG-BANG MODEL OF OUR UNIVERSE

The holoverse of recursively nested black holes gives us a tool to understand how our universe might have formed and evolved. The idea is that whatever happens to black holes in our universe, can happen to our block hole in our exoverse.

One option for the formation of our universe that I will not discuss further here is the simplest: there was a density fluctuation in a large cloud of heterogeneous matter in our exoverse, sufficient to create a black hole, and so our universe was born. Much like star formation in a gas cloud inside our universe, but on a much larger scale. A dramatic way for our universe to grow that I will also not discuss further is merging with other black holes.

Another option for the creation and growth of our universe arises from the structure of black holes in Figure 2: the bang-bang model. The bang-bang model opens up the possiblity that our universe started as a small black hole via stellar collapse and has been growing since then via mass accretion.

The bang-bang model is based on the observation that there are black holes in our universe that accrete mass, so our universe's black hole may be accreting mass in our exoverse. Accreting mass causes the event horizon to expand. The gravitational field holding the inner shell under pressure weakens as the event horizon expands away, until the pressurized inner shell explodes and blasts some of its matter back toward the center of the black hole. What happens to the inner shell is sort of like what might happen to a neutron star if gravity were to disappear.

A simple estimate for the amount of accreted mass needed to cause the next explosion is the total mass M_p of the black hole at the previous explosion. Given time, all of the mass from the previous explosion of the inner shell will eventually fall back to the inner shell. If no new mass is accreted during that time the inner shell will end up with all of the mass of the black hole. I think that if the black hole then accretes that much new mass on the outside surface of the inner shell, then the inside surface of the inner shell will be pushed far enough out of the gravity well that the pressure of the compressed matter will blast off the inside surface of the inner shell. That is because the rate at which the radius of the black hole grows is so much faster than the rate at which the material of the inside surface of the inner shell can fall back to the new event horizon. The old material of the inside surface of the inner shell has no time to repressurize.

Because the mass we need to accrete is the same as the mass we started with, with this simple estimate the black hole doubles in mass between inner shell explosions. If we know the mass M of a black hole today, and if we assume that the most recent explosion was today, and if the black hole has a constant rate of mass accretion $\frac{\mathrm{d}M}{\mathrm{d}t}$, then the maximum time to the next explosion $t_{\max}$ is:

$$t_{\max} = \frac{M}{\frac{\mathrm{d}M}{\mathrm{d}t}}, \tag{16}$$

or, solving for $\frac{\mathrm{d}M}{\mathrm{d}t}$:

$$\frac{\mathrm{d}M}{\mathrm{d}t} = \frac{M}{t_{\max}}. \tag{17}$$

If we guess that $t_{\max}$ for our universe is about 100 billion years $= 3.16 \times 10^{18}$ s, then we can plug in our estimate for the mass of our universe from Equation (5) into Equation (17) to estimate the mass accretion rate for our universe:

$$\frac{\mathrm{d}M}{\mathrm{d}t} = \frac{1 \times 10^{54}\,\mathrm{kg}}{3.16 \times 10^{18}\,\mathrm{s}} = 3.17 \times 10^{35}\,\mathrm{kg\,s^{-1}} = 1.6 \times 10^{5}\,M_{\odot}\,\mathrm{s}^{-1}. \tag{18}$$

I do not know what is happening in the exoverse outside our universe, but maybe accreting 160,000 suns per second is reasonable. That seems too high to me, though, so I expect that better models of inner shell explosion will lower that rate.

DISCUSSION

The idea that our universe might be in a black hole is not new. For example, see problem 21.9 in [1]. But, I suspect that the idea is usually rejected based on the belief that everything in a black hole should collapse to the singularity at $r = 0$. In other words, the arrows in Figure 1 should have been pointing toward the singularity at $r = 0$ instead of the toward the inner surface of the black hole at the Schwarzschild radius $R_S = \frac{2KM}{c^2}$.

However, there is a loophole in one particular coordinate system: absolute space and time.

In absolute space and time, the Schwarzschild metric has a coordinate singularity at R_S. The coordinate singularity can be transformed away by using a different coordinate system, such as Eddington-Finkelstein coordinates, in which case everything in the black hole collapses to $r = 0$.

However, if the developers of our universe used absolute space and time for our coordinate system, then the coordinate singularity at R_S is a real singularity in our universe. In which case, the singularity at $r = 0$ becomes repulsive and the singularity at R_S becomes attractive, as in Figures 1 to 4.

I suspect that absolute space and time is, in a certain sense, unique in this respect. In absolute space and time you can transform space into space (by rotating the spacial coordinates, for example), but you cannot transform space into time. I suspect that in any coordinate system where you can transform space into time you can make everything in a black hole collapse to $r = 0$.

Note that flat spacetime is not the same as absolute space and time. In flat spacetime you can transform space into time using a Lorentz transformation. In absolute space and time, space and time are completely independent of each other. The Lorentz transformation is a handy approximation in situations where you can ignore gravity, but when you add gravity to electromagnetism in absolute space and time [3], the Lorentz transformation is no longer necessary.

All the 3D video games whose coordinate systems I know of use absolute space and time. If the developers of our universe are anything like us, absolute space and time is the coordinate system they should have chosen.

ACKNOWLEDGEMENTS

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