About background radiation, spacetime curvature and empty space

by Giuseppe Gori

© June 20, 2015 (See copyright statement below), Rev. July 12, 2015

Abstract

The theory of general relativity has been applied to the math, geometry and physics of cosmology for a hundred years. These theoretical results have been routinely compared and matched with our observable universe. The light, coming to us through spacetime, follows a straight line. By looking towards different directions in the sky we perceive the observable universe as a sphere, all the way back to the origins of the universe. This article describes a "hypothesis" that does not derive from mathematical analysis, but from "philosophical intuition". What we see, when we observe the universe far away back in spacetime must be what "everything" was, according to cosmology theories: a visible footprint of a cosmic event that happened 13.7 Billion years ago. By interpreting the observable universe through this view and a relativistic geometry we can better understand what we see, such as the background energy, distant objects and the quantity of empty space around them.

---

1. The incongruences in understanding our observable universe

The view that our universe is isotropic and homogeneous to an observer looking in any direction of the universe and looking from any point of view[1] has been generally held as valid.

When astronomers look at spacetime[2] with today's telescopes, they say they are looking at the "edge" of the universe, back at the time of the big bang.

Astronomers Penzias and Wilson received the Nobel prize for physics in 1978 for their 1964 discovery proving the Big Bang: an almost perfectly uniform "background radiation" of about 3 degrees Kelvin coming equally from all directions of the sky.

The enormous progress in recent astronomic observation, led us to some incredible discoveries, but at the same time problems remain to be solved.

We recognize the following incongruences in the currently held astronomical interpretations of what we see in our observable universe:

1. We expect the Friedman's assumptions to be valid at any age of the universe's development. Some cosmological theories (including the Big Bang theory) require the existence of a singularity point (about 13.7 Billion years ago). Friedman's assumptions could have been valid then, as they may be valid now, however, we cannot apply the same assumptions across different time ages. For example, we cannot assume that the density of the universe "here, now" is similar to the density of the universe at a time close to the initial singularity event[3].

   This incongruence appears in the view of our expanding universe often described by the "balloon analogy". This analogy of an expanding surface helps us imagine the same type of expansion in a uniform region of 3 dimensional space. If that 3D region contained a singularity, such as a specifically recognizable point, we would see this point moving away at the same rate. Now we need to make the further step from imagining 3D space to imagining 4D spacetime.

   As we look at the light that left distant galaxies moving "away" from each other, we also understand that what we see happened in the past. However, singularities that happened in the past do not "evaporate" into nothingness. We can still see them as specific structures, in a specific point of our visible universe, at least back to about the initial singularity event. However, we "got used" to see these different structures in space, farther and farther away, in different directions in the sky, and we cannot think of all of them as coming out from a singularity point.

The incongruence in the current astronomical view is the following: If we can see clearly back in space distant galaxies and structures, as they existed when the universe was young, why we do not see these structures as escaping from the same singularity point in the sky? Why can we not see the "remains" of the initial singularity as an object in a specific position in the sky, but we see it as a uniform "halo" in the background of our sphere of observation?

Our hypothesis, described in the next section, explains this incongruence.

2. The second "incongruence" is the dichotomy between the math of the theory of relativity, used by physicists, and the assumptions derived from the observations of the sky by astronomers.

   When we look at objects whose light reaches us "here, now", we are looking back in time. No one disputes that we are seeing how the objects were in the past: their "apparent" size, shape, physical and chemical properties. However, astronomers seem to overlook the relativistic effects of a curved spacetime: The objects we are seeing are not "where" we see them, both because light travels to us through a warped spacetime, and because when we are looking "in the past" we are seeing a different size universe, thus our observations should be corrected accordingly, using the non-Euclidean geometries matching the theory of relativity.

   We cannot assume that the distance between two distant galaxies, or the size of a distant structure from one end to the other, can be measured by simply calculating the sine of the angle between the two directions. The following must be considered:

   - that the light traveled two different (possibly converging) paths through a curved spacetime, and
   - that the whole universe at that time was much smaller, thus the apparent relative distance between two points in our sphere of observation gives us a false (bigger) angle.

   Both effects are more and more relevant as we travel "back in time".

   As a real example, in 2013 a structure has been discovered, the "Hercules–Corona Borealis Great Wall", whose "apparent" dimensions have been estimated to be approximately 6, by 10, by 10 Billion light years (5.7, by 9.5, by 9.5 * 10^{25} m). The calculated distance from us, where the structure was at the time we see it, is 10 Billion light years. This means that the structure being observed is only 3.7 Billion years "young", after the initial singularity event. At that time the size of the universe, according to the cosmological principle, would have been only 3.5 * 10^{25} m.

   The Hercules–Corona Borealis Great Wall would be an object bigger than our whole observable universe at that time. This means that either the cosmological principle is not valid for those distances back in time, or that our interpretation of what we see is incorrect, or both.

2. A different view

We are "somewhere" in the universe, but at the center of our ***observable*** universe. What we are seeing is an inverted spacetime image: an apparent sphere, whose surface (the background) is actually the point of spacetime at the time of the initial singularity event[4].

According to both, the Big Bang theory and the Black Hole Universe theories, the initial singularity event would have emitted cosmic microwave radiation at that time:

a) If we think in terms of the Big Bang theory, what we perceive as background radiation is the energy as it was emitted by the initial singularity event 13.7 Billion years ago.

   The matter that makes us, our solar system, was "there" at the time of the initial singularity event. By looking further and further with telescopes, we are not "chasing the background radiation out in space", but we are returning to the initial singularity event, when our universe (much smaller) was all there. We are seeing the matter/energy that makes our universe back in time. Since along the light path there are generally no discontinuities, that space included the matter/energy that is "**here**, **now**".

b) If we think in terms of the Black Hole Universe theory, what we perceive as a background radiation could be the radiation emitted by the mass/energy at the center of the Black Hole Universe, presumably as it appeared about 13.7 Billion years ago.

   The matter that makes our solar system, could have been "captured" by our Black Hole Universe any time (in a cosmological time scale) between 13.7 Billion years ago and now. It would have been captured in a violent way in an early age of the Black Hole Universe, or in a relatively non violent way if captured "only" a few Billion years ago.

   The important observation is that our universe, 13.7 Billion years ago, had to be much smaller, of the same order of magnitude as the universe postulated by the Big Bang theory (See Section 4.4), since the Hubble constant would have to be valid.

Thus, in both views, when looking further and further with telescopes, we are not "chasing a halo of the background radiation out in space", but we are returning to the initial singularity event, when our universe was much smaller.

Let's suppose we mentally travel back through space following a direction in the sky. When we reach that particular point back in time when we believe the initial singularity event occurred, we are looking at our old universe "there".

The same is true if we followed another direction in the sky. All directions lead to the same event. Although each direction seems to us straight, we know from relativity that space is curved. It "warps" on itself[5].

When we aim to reach that initial singularity event, by traveling "back in time", we reach it in spacetime. We cannot be "outside" spacetime, that is we need to apply relativity to our concept of space.

Our hypothesis

> ***We are not seeing a "halo" of the initial singularity event (background radiation), but we are seeing the real thing: the singularity event and its observable energy through spacetime, visible as an apparent sphere.***

We assume spacetime to be uniformly expanding, as we see it from our spot in the universe. However, we can imagine spacetime as actually curved on itself "inside out" by 360 degrees, between "here, now" and 13.7 billion years back in spacetime.

This "curvature" is due to the total quantity of energy/mass across the observable universe (calculations in Section 4.1, below).

In our ideal representation of the universe, if we keep time as a constant, then the space dimensions must be represented as "warped" or curved[6].

2.1 Analogy of a flat map of the Earth:

Let's imagine a map of the Earth drawn on a flat piece of paper (a two dimensional image of a three dimensional sphere). It can be drawn by maintaining the angles with the meridians[7] (See, for example: maps.google.com). If we start by looking at the regions close to the Equator, we see that these are represented with certain relative dimensions that do not warp reality too much, but as we go towards the poles, things appear "warped". For example, northern Canada and Greenland appear bigger than regions closer to the Equator, and appear more distant from each other, until the North Pole **appears as a segment as wide as our map** when in reality it is a point. Similarly, our universe appears as a sphere: a three dimensional image of the four dimensional spacetime. Its background (after traveling back all the way in spacetime), looks like a sphere, when in reality it **was** a point.

One way to understand the "warped" spacetime is to think "straight" and compute the mathematics to correct our perception. Some mathematicians can "see" the formulas alive and working in their mind. Most of us instead can better relate to a diagram explaining reality. We can construct a three dimensional model of spacetime, representing the more complicated four dimensional reality.

2.2 Analogy from elementary geometry:

We all know, from elementary geometry, that an ideal line at infinity is cyclical and that parallel line "meet" at infinity. This concept may help visualize our representation of spacetime presented in the following diagram.

3. Conceptual diagrams of spacetime:

As our galaxy travels away from the initial singularity point at an accelerated speed, our observable universe appears as expanding in every direction, but according to the relativity theory, spacetime is "warped".

When choosing a graphic representation for light traveling across a curved space, we could represent light as straight lines and represent spacetime as "warped". However, we do not find this intuitive, as we are accustomed to only three dimensions orthogonal to each other. We find it instead more intuitive to maintain the space dimensions as we are accustomed to, and represent light paths as "curved".

3.1 A conceptual diagram from our point of view:

In the following diagram, we make a further simplification: we represent the moment of the initial singularity and "here, now" in the same point, so that the time coordinate is reduced to a single point (where we are).

If we imagine looking with a telescope at one point in spacetime on the "edge" of our observable universe, we are looking at where we were at the time of the big bang. Thus we can say that point on the "edge" and all the matter/energy that makes us now, **at that time** was **in that same point**.

We can represent what we see (what happens to light) while traveling back in spacetime as in the following two dimensional diagram: a three dimensional representation of the paths of light when observing one point of background radiation in the four dimensional spacetime:

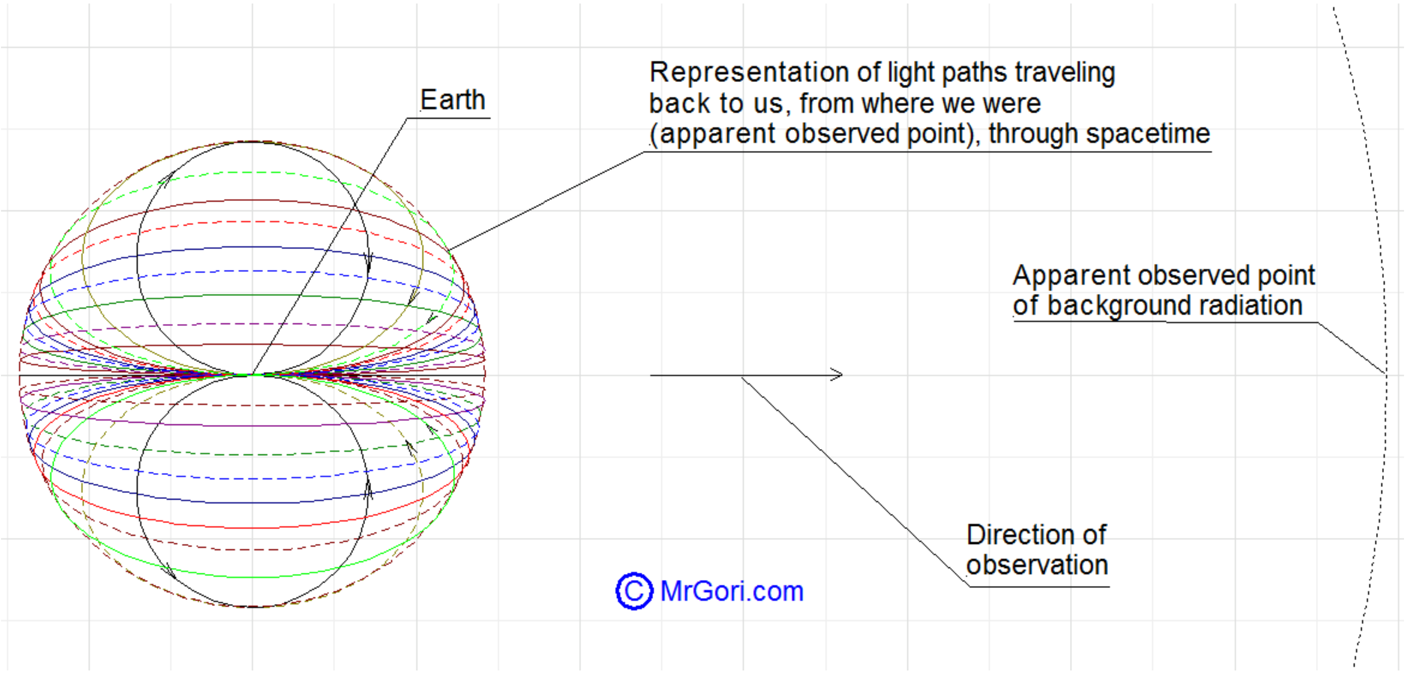

Diagram 1: Observable universe from our point of view

The light coming to us from the direction of observation may be represented as traveling along different paths, coming from one apparent point, corresponding to the initial singularity point in spacetime. The path of light can be represented by any one of the possible paths (different color pairs in the above diagram).

There are an infinite number of equivalent "parallel" paths, for each observed point, converging back to our point of observation.

The same is true for any other observable point on the "background", when we change the direction of observation.

Similarly, any observable point in the universe "in between", somewhere along the path of light, can be represented as a point in our "curved" light path representation.

3.2 A conceptual diagram from a different point of view:

In the following diagram we "develop" the time dimension from one point to a line, from "here, now" to the initial singularity point. We can represent our position as "far away" in spacetime from the initial singularity event.

We can imagine our point of view to be somewhere outside our observable universe, constant with respect to the initial singularity reference frame, as follows:

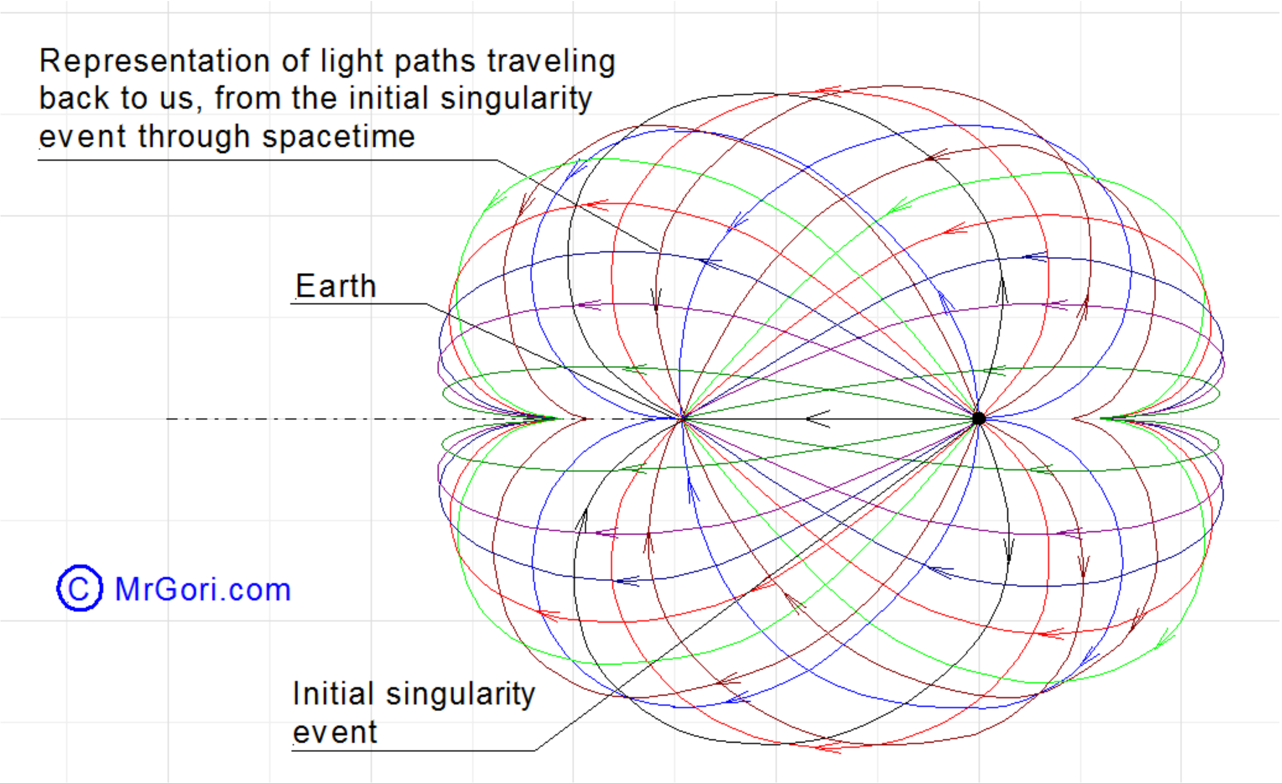

Diagram 2: Point of view outside of our observable universe

In the above diagram (a projection from four dimensions to two) we can only represent the possible light paths in the same plane as our sheet of paper, which includes the singularity point. For this reason, the diagram cannot "do justice" to a four dimensional volume.

The diagram tries to show that no matter which direction we choose when observing our universe, we are looking towards the same initial singularity event, seeing the light coming to us through a "warped" spacetime. There is no preferential direction.

From the above diagram we deduce that our observable universe is a subset of spacetime. It is a four-dimensional region with no "outside surface", which can be represented geometrically as a quadratic volume.

3.3 Our hypothesis (in different words)

When we observe the background radiation coming from different directions in the sky, we are not looking towards different ends of the universe, but we are looking towards the same initial singularity event, from different points of view, as we follow different paths through spacetime.

4. Implications:

If our hypothesis is true, then it should verify the following conditions:

a) It must be consistent with current scientific knowledge and observation, and
b) It must help explain some currently unexplained observation.

4.1 Total mass/energy and size of the event horizon

From the above diagrams, we require that our observable region of spacetime is "warped" enough for light to "turn on itself". We could phrase the same phenomenon by saying that the total mass/energy of our observable universe is enough for creating a region from which light cannot escape. A region with an "event horizon" as big as the observable universe. A region with an "event horizon" as big as the observable universe. A region where, when we look towards what we perceive as "outside", we are actually seeing its singularity point within.

Fortunately astronomers were provided the tools for this calculation: The Schwartzchild formula[8], which is used to calculate the radius ***r*** of the event horizon for black holes. This can be applied to the whole of our observable universe.

We know that when a large quantity of mass is concentrated enough, this prevents light from escaping the black hole's event horizon. We also know that as the mass increases, the density of the mass required to cause a black hole event horizon diminishes, according to the formula:

$$r = \frac{2GM}{c^2}$$

Where:	G = Universal gravitational constant	=	$6.673 * 10^{-11}$	$N*m^2/kg^2$
	M = Mass of the observable universe [9]	=	10^{53}	kg
	C = Speed of light in vacuum	=	299,792,448	m/s

From this simple calculation we obtain a radius of the event horizon of our observable universe of approximately $1.5 * 10^{26}$ m, which is of the same order of magnitude of the estimated radius of the apparent sphere observed by astronomers: 13.7 Billion light years ($1.3 * 10^{26}$ m).

From the above calculations we see that the total mass/energy of our observable universe is enough, and with enough density for the light not to be able to escape from it. This is not a demonstration, but a confirmation that our hypothesis is plausible.

The above coincidence, between calculated size of the observable universe and theoretical radius of the event horizon of a black hole of equivalent mass, is so compelling that recently two cosmologists, first Tianxi Zahng[10] and then U.V.S. Seshavatharam[11], proposed completely new cosmological models based on the observation that our universe could be an expanding black hole.

4.2 The red shift of distant galaxies

Assuming that we agree on the phenomenon of the red shift observed on distant galaxies, then we have to agree that, in our travel back in spacetime, those galaxies move "away" from "**here, now**".

We are looking at the initial singularity point in spacetime from an observation point which is somewhere else in spacetime.

We know that our distance from the initial singularity event, in relativistic geometry, has a time dimension of 13.7 Billion years. According to our hypothesis , we observe distant galaxies apparently moving away from us in the direction of the initial singularity point.

Let's invert the reference point from "here, now" to the initial singularity point and see if our observations are still valid.

Everything, including distant galaxies, moved away from the initial singularity point. However, we are moving away both from that point, and from distant galaxies, at an increasingly faster speed[12].

With respect to the background radiation (our reference point), we move away even faster.

Our closer galaxies in every direction, our travel companions, move away from the same singularity point at a rate of speed closer to ours, as expected and as observed.

In other words, our observations are consistent with our "inverted" view, where the initial singularity frame is used as our reference frame. However the interpretation of what we observe may need to change.

4.3 Uniformity of background radiation

Our hypothesis could explain the uniformity of the background radiation: If you were looking at a nuclear explosion above the Earth's atmosphere from different points of view, would you be surprised to measure an almost uniform energy value?

Similarly, by going back in time looking towards different directions we observe the energy emitted by that single event from different points of view, having very small temperature fluctuations.

4.4 Quantity of empty space

In Section 1, point 2, we introduced the incongruence of treating the visible universe as a sphere and the errors of attributing sizes to distant structures we observe.

In the same way, we attribute size to empty space in between structures.

According to the Hubble constant, the universe was much smaller 13.7 Billion years ago.

More precisely, according to the Big Bang theory, our universe started "clearing", photons ceased to scatter at all and began to propagate freely through the Universe. During this "Photon Epoch" the cosmic background radiation started propagating. This is between 10 seconds and about 379,000 years after the Big Bang. At the end of this Epoch (last scattering surface) the background radiation stopped being emitted.

In the best case scenario, the biggest possible universe emanating background radiation would have had a radius of 84.6 Million light years, or $8 * 10^{23}$ m. That would be about 550 times smaller than it is today.

For similar reasons, if other cosmological models are used, the size of the observable universe, in the same "ages", would have to be of the same orders of magnitude in size.

When looking so far back in spacetime, the "empty space" and all the three dimensional objects, appear much bigger than they were and measurements need to be adjusted according to how far back we look, until, when looking back to the background radiation, we need to adjust the relative dimensions of our immense background sphere by at least a factor of 550 for each of the axes, before even applying relativistic concepts of "warped" spacetime.

We need to use a non Euclidean, relativistic geometry[13] to interpret and measure distances of what we perceive by looking back into spacetime.

No matter which direction we look at with telescopes, we "travel" in space expanding our view. However, according to our hypothesis, as we observe the universe, traveling far back in spacetime, the "quantity of empty space" seems to expand, but in reality it shrinks.

If we imagine going further back in time another 379,000 years, all the empty space in the sphere of observation **would not be there** and all matter **would be** super-compact, in one small solid sphere.

5 Conclusion:

If the above hypothesis is correct, then our astronomic observations need to be re-interpreted, in order to explain what we expect to see, what we perceive and what our universe actually is.

Giuseppe Gori holds a "laurea" degree in Computer Science from the University of Pisa (1973). He worked at the IBM Scientific Center in Pisa, was assistant professor at the University of Pisa and briefly visiting professor at the University of Western Ontario. He worked again with IBM at its Development Lab in Don Mills, Ontario and with GEAC Computers, before starting his own business, consulting in computer communications. He is running a manufacturing company developing a new type of water treadmills. Recently he and his brother Nazareno, a mechanical engineer, won an international award for the idea and the design of a new cloth-washing technology.

© Copyright:
You are free to copy and redistribute this article in any medium or format under the following terms:

Attribution: You must give appropriate credit, provide a link to this article, including this copyright notice and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

Share alike: If you remix, transform, or build upon this material, you must distribute your contributions under this same original copyright license.

---

[1] Friedman's assumptions, Alexander Friedman, 1922.

[2] Lorentzian/Einsteinian/Minkowskian Spacetime.

[3] If we think in terms of the "Big Bang" theory, the major event at the origin of the process, was an explosion event, which left a visible "footprint" as the Cosmic Microwave Radiation, or background radiation, about 380,000 years after the initial explosion. If we think in terms of a "Black Hole Universe" theory, then the initial singularity event is the star-size expanding, hot and dense Black Hole that initiated our universe.

[4] More precisely, in the Big Bang theory, the background radiation corresponds to the time of the Big Bang plus about 380,000 years.

[5] How spacetime warps on itself will requires further thought. Here we assume, from the above observation, that the observable region of spacetime is closed (as opposed to flat, or open) and that it can be represented by a hyperquadratic geometrical figure.

[6] The Geometry of Relativistic Spacetime: from Euclid's Geometry to Minkowski's Spacetime, Jacques Bros.

[7] A Mercator map.

[8] This is derived from the formula of the escape velocity: v=SQRT(2GM/r), when the velocity is substituted with the speed of light (c) and the formula is solved with respect to the radius, in order to find the radius of the event horizon.

[9] This total mass/energy does not include dark matter or dark energy.

[10] "A New Cosmological Model: Black Hole Universe", Tianxi Zhang, Department of Physics, Alabama A & M University, Normal, Alabama, 2009 http://www.ptep-online.com/index_files/2009/PP-18-01.PDF

[11] "Physics of Rotating and Expanding Black Hole Universe", U. V. S. Seshavatharam, Honorary Faculty, Institute of Scientific Research on Vedas (I-SERVE), Hyderabad-35, India, 2010 - http://www.ptep-online.com/index_files/2010/PP-21-02.PDF

[12] Whether the rate of acceleration will eventually reduce and the universe contract remains to be investigated.

[13] Ref.: Minkowski's Spacetime.