Event-Horizon-Model

it's not where we come from but where we go to that makes up the properties of our universe

Harald Kunde
email: business@harald-kunde.de
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Contents

1 Summary

This document contains hypotheses on the structure and evolution of the cosmos. In Section 2 we construct the so-called Event-Horizon-Model in order to get a new understanding of how the universe evolves. The section will not provide information on its genesis. This is reserved for a separate document. In section 3 we state some tests for falsification of the model. Three appendices on Doppler effects in supernovae Ia and quasars and the orbital period of our sun in the milky way galaxy complete the model.

The second section collects evidence for our main picture, that we are inside the universe's event horizon and move towards it. The event horizon is actually perceived as that of a black hole. The film "mass plunges into the singularity of the black hole" (call it "singularity-film") is processed in reverse order (call it "event-horizon-film"). The fall into the singularity is, so to speak, already behind us, we are moving towards the starting point, the event horizon.

The so-called *dark matter* concept will be replaced by a rule we call "Mach's minimal principle" in honour to Ernst Mach, stating that *radial acceleration of any rotational system may not fall below the limit radial acceleration given by the mass of the universe and its age in comoving distances*. We shall see that the limit radial acceleration with respect to *NOW* calculates to $1,16 \cdot 10^{-10}$ m/s^2 [1] and thus is nearly equal to the limit radial acceleration of MOND. Moreover the limit radial acceleration is dependent on the age of the universe. In fact it gets bigger for more distant (older) objects.

The physical mechanism for Mach's principle is based on a radial velocity vector field which describes the expansion of our universe. This field is orthogonal to every rotation system, i.e. galaxies or clusters. Its derivative at time *NOW* will be the radial acceleration of MOND, and ensures that any radial acceleration in a rotation system of this universe may not fall below the limit radial acceleration at time *NOW*. See "On Kip Thorne's limit for rotation of black holes" for details.

There is no need for dark energy in the event-horizon-model, although expansion of the universe being smoothly accelerated nearby *NOW* (see scale factor evolvement). We suppose that the conclusion on observations of distant supernovae Ia with respect to expansion of the universe are wrong. The distances with respect to expansion need to be reduced by Doppler blueshift (see appendix 1) and the assumption is, that this has not been done. The Hubble constant fails to be a constant, but decreases from a value of 72 km/(s*Mpc) 1 billion years ago to 67,74 km/(s*Mpc) *NOW* (see evolvement of the Hubble constant).

There was no inflation. Cosmic inflation has been introduced by Alan Guth in order to solve the problem of homogenity of our universe. This shows the main difference of standard model and event horizon model: The standard model tries to find a solution of the problem of homogenity by stating an extremely smooth singularity whereas the event horizon model focusses on where we are going to. Since the event horizon is completely homogeneous and we are approaching it, our universe is asymptotically homogeneous. Also we will see that expansion rate H(t) of space will grow indefinitely on approaching the singularity. Expansion rate according to *NOW* will calculate to 67,74 km/(s*Mpc).

[1] We will write a comma for the decimal point throughout the document.

Flatness: If we calculate the Hubble flow we see that we now have a value that will be reached again at the event horizon after small reduction till then (see 2.3/conclusion B). Thus the universe state *NOW* is almost flat.

It is a well known fact, that radial structures in the microwave background at an age of ~380.000 years after the Big Bang (recombination phase) are factor ~1100 smaller than at time *NOW*. Since 1093 is the redshift factor[2] for photons of the microwave background, this is said to show evidence for the flatness of our universe. The idea of recombination is, that photons could escape the plasma which due to cooling formed first atoms. Today's estimates for the baryonic mass of our universe are up to 10^{53} kg. This would be a minimum of the mass, the photons would have to escape from. An essential gravitational redshift should have taken place. When this would be taken into account, then the age of our universe naturally would be less than 13,8 billion years, since for instance the redshift 1092 of the microwave background would fall into at least 2 parts: one factor for the expansion of the universe and one for gravitation.

The *event horizon model* states that photons at recombination phase did not just escape, but are result of a gigantic explosion at that time, leading to a blueshift factor *F_b of exactly 0.5* given by formula $F_b = \gamma*(1-\beta*\cos\alpha)$, with $\beta=v/c$, Lorentz factor γ and α being the angle between the flight path of the particle and the line of sight. In our case: $\alpha = 0°$. This yields a value of *$\beta=v/c = 0,6$*. So, in the event horizon model the redshift factor $F_r = 1093$ for microwave background is split into $F_r = F_e*F_g*F_b$ where F_e (≈37,9) denotes redshift for the expansion, F_g (≈57,7) redshift due to gravitation and F_b (=0,5) due to blue shift of explosion. Together they correspond to an age for recombination of 8,874 Mio. years in this model. And the age of the universe would be ~9.7 billion years. Note, that the ratio 9700/8,874 is exactly 1093, the measured redshift factor of the microwave background.

Remark on horizons and event horizon:

At every point of the universe there exists a horizon, beyond which observation may not take place. This horizon changes as the world line evolves. The event horizon in contrast describes a limit horizon. We will never be able to look or act across.[3] One may interpret this as a black hole. And if the mass of the black hole is large enough you may feel quite comfortable in it at additional radial accelerations of order 10^{-10} m/s^2. The course of the Hubble curve is such that we are now at a value that is getting still a little lower, only to then increase again and close to the event horizon roughly reach the value that the parameter has today (see evolvement of the Hubble constant).

2 If z is the redshift, the redshift factor is 1+z.

3 For theoretical reasons there could be impacts from outside. But the effect of increased event horizon would affect only an observer just crossing. So, our reverse process of plunging into the singularity should be atomic and therefore the same is true for our event-horizon-movie.

2 Event horizon and the Event-Horizon-Model

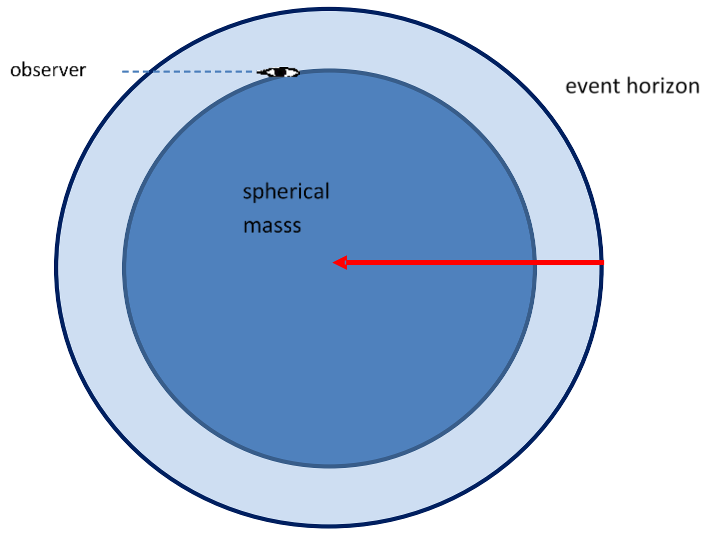
2.1 Schwarzschild metric

Since we expect the rotational velocity of our universe to be extremely low we use the Schwarzschild metric to describe it. The line element (Wikipedia - Schwarzschild metric, 2018) for the Schwarzschild metric of the so-called outer Schwarzschild solution using signature (-,+,+,+) has the form:

$$ds^2 = -(1-\frac{r_s}{r})*d(ct)^2 + \frac{1}{1-\frac{r_s}{r}}*dr^2 + r^2*d\theta^2 + r^2*\sin^2(\theta)*d\varphi^2 = -c^2*d\tau^2$$

where there is c the speed of light, t the time coordinate, (r, r*θ, r*sinθ*φ) sperical coordinates, τ the proper time and $r_s = \frac{2GM}{c^2}$ the Schwarzschild radius with G the gravitational constant, and M the mass.

Remark: This solution of Einstein's field equation is initially defined only outside the event horizon ($r>r_s$). Usually Schwarzschild second solution for the inner region is used to smoothly continue this outer solution. In this paper we will use in contrast the first solution inside the event horizon, too. The following picture roughly illustrates the idea.



For most of the cosmological objects like stars, galaxies and so on, the Schwarzschild radius r_s is such that the corresponding event horizon lies inside the boundary of the object. We have rs ~ 2.954 m for the sun for example, about $4*10^{-6}$ of the sun's radius. So the picture above would not make sense for such a case. The same would be true for a supermassive black hole like Sagittarius A* in the center of our galaxy having 4,1 million of solar masses. Its Schwarzschild radius would be approximately 12 million km, thus ~8% of the distance between sun and earth. The tidal forces inside the event horizon would tear us apart. But for much bigger black holes like our universe, the above picture would make sense. Acceleration due to gravity near the boundary r_s for a mass of say $0{,}92*10^{53}$ kg would reduce to $\sim 10^{-10}$ m/s^2. For Sagittarius A* the corresponding value would calculate to ~8,2 million m/s^2!

Further remarks:

The metric has a coordinate singularity at the event horizon. Changing for instance to Kruskal-Szekeres metric may avoid the singularity. We do not change. Crossing the horizon $r>r_s$ --> $r<r_s$ we recognize:

- r takes the role of time, ct the role of the spacelike radial component

Since radial and time component change role at the horizon we adopt the line element:

$$ds^2 = -\frac{c^2}{\frac{r_s}{ct}-1}*dt^2 + (\frac{r_s}{ct} - 1)*dr^2 + (ct)^2*d\theta^2 + (ct)^2*\sin^2(\theta)*d\varphi^2 = -c^2*d\tau^2$$

Now, for an observer participating in the cosmic evolution only, precisely one having θ=φ=0[4], we get for the physical distance:

$$D(ct_1,ct_2) := \int_{t1}^{t2} \frac{c}{\sqrt{\frac{r_s}{ct}-1}}\, dt = [-\sqrt{(r_s - ct)*ct} - r_s*\arctan(\sqrt{\frac{r_s-ct}{ct}})\,]_{t1}^{\;t2}$$

$$D(ct) := D(0,ct) = = r_s * \frac{\pi}{2} - \sqrt{(r_s - ct)*ct} - r_s*\arctan(\sqrt{\frac{r_s-ct}{ct}})$$

This measuring of time belongs to the singularity-film. For ct = r_s we get $D(r_s) = r_s * \frac{\pi}{2}$, for ct = 0 D(0) = 0. Change to the event-horizon-film is accomplished by the (only time-relevant) transformation: $d(0,ct): = r_s * \frac{\pi}{2} - D(r_s-ct) = D(r_s) - D(r_s-ct) = D(0,r_s) - D(0,r_s-ct) = D(r_s-ct,r_s)$.

Obviously: $d(ct): = d(0,ct) = \sqrt{(r_s - ct)*ct} + r_s*\arctan(\sqrt{\frac{ct}{r_s-ct}})$ and

$$\frac{d}{dt}\, d(ct) = \frac{c}{\sqrt{\frac{r_s}{r_s-ct}-1}} = \frac{c}{\sqrt{\frac{r_s}{r_s-ct}-1}} = c * \sqrt{\frac{r_s-ct}{ct}} = c * \sqrt{\frac{r_s}{ct} - 1}$$

For photons (dt=0) on the boundary, we similarily get:

$$d(r_1,r_2) := \int_{r1}^{r2} \sqrt{\frac{r_s}{r} - 1}\, dr = [\,\sqrt{(r_s - r)*r} + r_s*\arctan(\sqrt{\frac{r}{(r_s-r)}})\,]_{r1}^{r2}$$

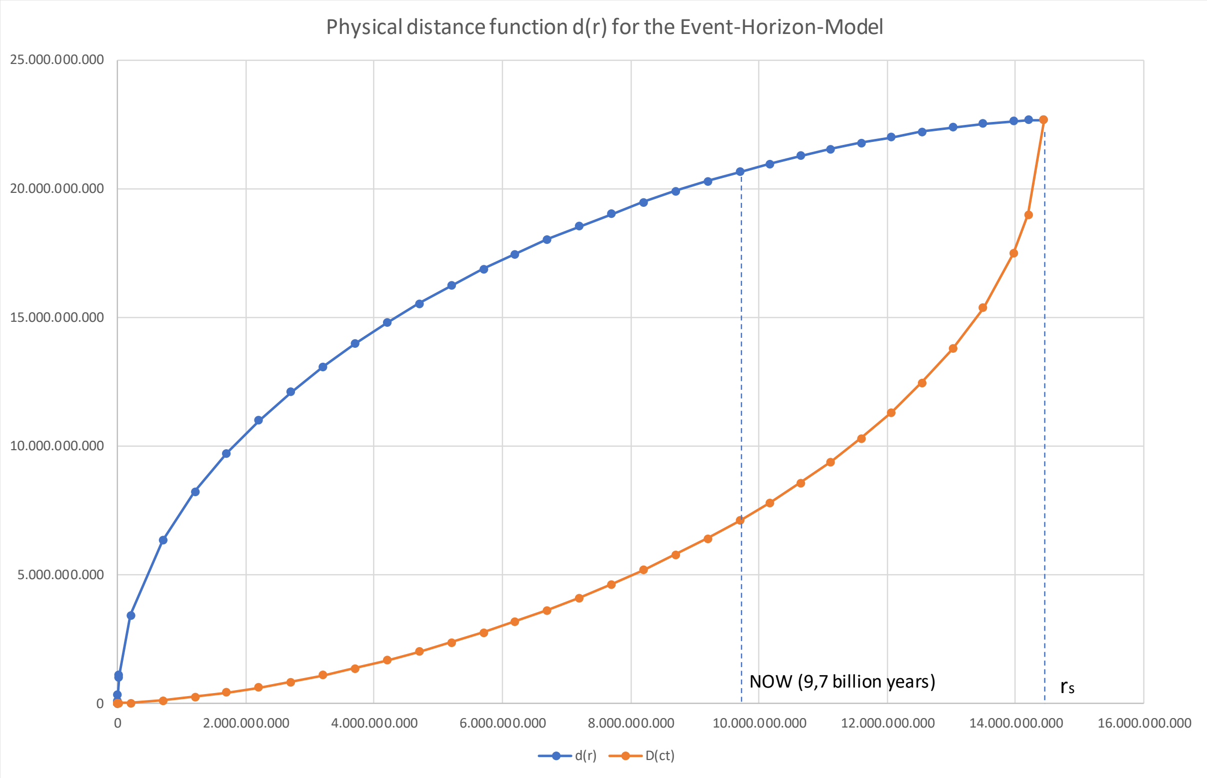
Setting r_1=0 (Big Bang initial) and r_2=r we get for the distance function:

$$d(r) := d(0,r) = \sqrt{(r_s - r)*r} + r_s*\arctan(\sqrt{\frac{r}{(r_s-r)}}$$

$$d(r,r_s) = r_s*\pi/2 - \sqrt{(r_s - r)*r} - r_s*\arctan(\sqrt{\frac{r}{(r_s-r)}}$$ especially: $d(r_s) = r_s*\pi/2$.

The following diagram shows distance functions D(ct) and d(r) using r_s = 14,4 billion light-years and *NOW* = 9,7 billion light years:

[4] The solution will serve only to derive the expansion rate. Moreover we assume that the topology of the universe is such that the expansion rate of the boundary reflects the one of the inner volume

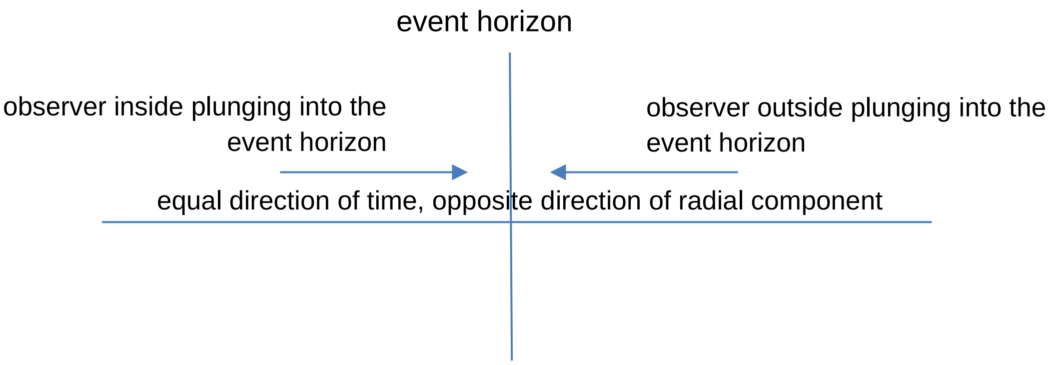


We now define the expansion factor to be:

$$F_e(r) := \frac{\mathrm{a(now)}}{\mathrm{a(then)}} := \frac{\frac{ct_0}{\mathrm{d}(ct_0)}}{\frac{\mathrm{ct}}{\mathrm{d(ct)}}} = \frac{\frac{\mathrm{d(ct)}}{\mathrm{d}(ct_0)}}{\frac{\mathrm{ct}}{ct_0}}$$

where now: = t_0 = r_0/c being the age of universe from our point of view and a(t) being the scale factor r/d(r) (Wikipedia - Skalenfaktor, 2016)[5] with r=ct.

On the relativity of frames: We already noted that an observer at another point of the universe in general would get a different value of inner mass and this way another value for r_s and also for the age of his universe. This observer would process his own film of approaching the event horizon. And like our film his film would be atomic too.



5 Note that the scale factor is defined inverse to the one in Wikipedia because of reverse movie

2.2 Event horizon of the universe

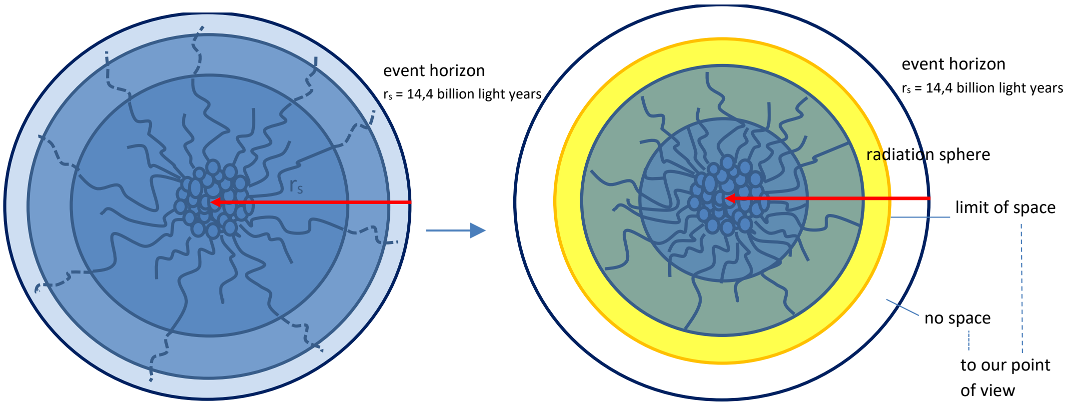
The mass of the universe has been estimated using different methods for calculation to be approximately 10^{53} kg (Wikipedia - Universum, 2018). Using a value of $0{,}88 \cdot 10^{53}$ kg and ignoring dark matter aspects, we would get a Schwarzschild radius $r_s = 2GM/c^2$ for the universe:

$r_s = 1{,}30675 \cdot 10^{26}$ m = 13,8 billion light-years.

Using a value of approximately $0{,}92 \cdot 10^{53}$ kg for the baryonic matter and still ignoring dark matter one would obtain a Schwarzschild radius r_s of ~14,4 billion light-years.

Dark matter concept will be replaced in the model to come by a principle called Mach's minimal principle. The radial acceleration of the mass inside the radius corresponding to *NOW* will be the limit radial acceleration that no other radial acceleration may fall below. In 2.3/conclusion E we will see that this limit radial acceleration equals the value of a_0 in the modified law of gravitation in MOND (Wikipedia - Modified Newtonian dynamics, 2018).

The following picture illustrates the „singularity-film" (the reversal to our film):

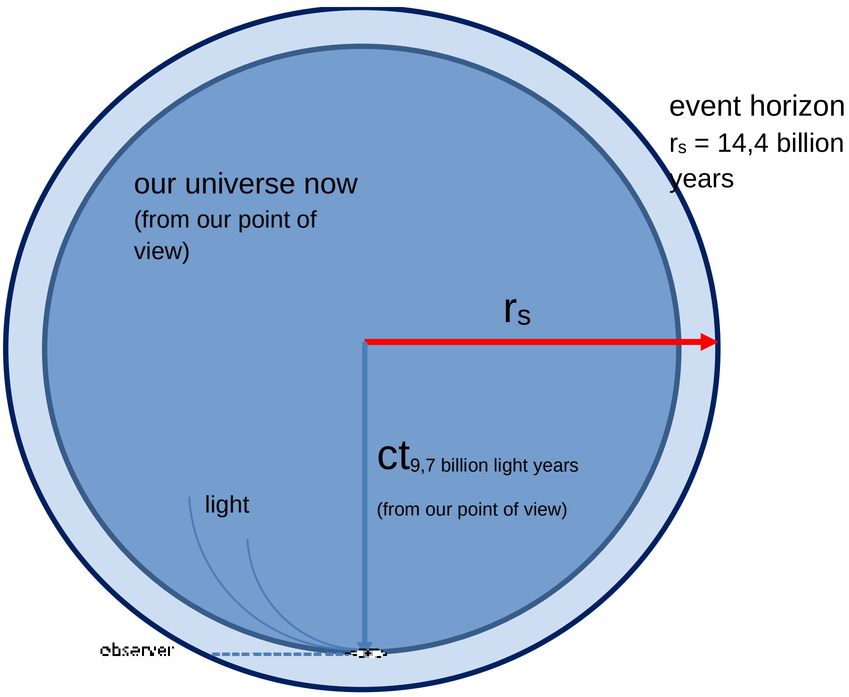


Compression of space in the „singularity-film" (the radiation sphere herein is symbolical, to illustrate that radiation pressure forces expansion of space in the event-horizon-film and therefore slows down compression in the singularity-film)

2.3 Event-Horizon-Model

For the event-horizon-model on the evolution of our universe we suppose:

1) The general theory of relativity (ART) applies, also we assume conservation of energy and spin[6]
2) The universe is a black hole of Schwarzschild-type without a full rotation at the event horizon, though the mass inside the radius we reached having a tiny angular velocity of ~$3*10^{-140}$ 1/s [7]
3) The mass of the universe in our event-horizon-film is ~$0{,}92*10^{53}$ kg
4) The age of the universe (from our point of view) is ~9,7 billion years
5) The outer Schwarzschild solution may be continued to the inside according to 2.1
6) The topology of the universe is such that expansion rate on the boundary is equal to the one inside
7) The dark matter concept is replaced by the so-called Mach's principle of minimal radial acceleration (name in honour to Ernst Mach), stating that no radial acceleration may fall below the value of the limit radial acceleration[8] (see conclusion E)

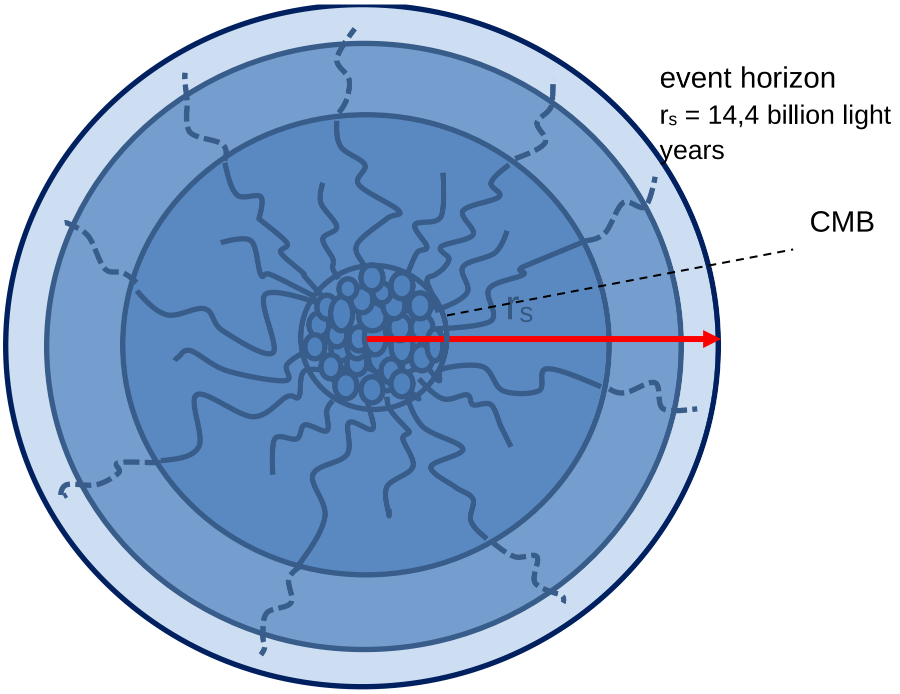


Development of space-time (space-like coordinates reduced to radial one): In our event-horizon-film the universe is getting smoother all the time

6 conservation of energy will not be used within the model but will be part of the general picture associated with it. Energy that seems to be lost by redshift of photons in this picture is assumed to be conservated in the reduced curvature of the universe (in the event-horizon-movie). This energy plays no role in gravitational effects since most of it is part of the border not part of our inner sphere.

7 The angular velocity at the radius of *NOW* is such that the momentum is of the order of ħ

8 The observed limit radial acceleration thus is dependent on the observer, that means that an observer somewhere else may see a different limit radial acceleration



Our event-horizon-film: Expansion of space to the event horizon (first there is a structure of bubbles and then getting filament structure by expansion; picture shows different phases). The bubbles expand to the later voids in our universe.

Conclusions/explications

A) According to the event-horizon-model we are on our way to the event horizon of the universe. For the Schwarzschild radius we get:

$r_s = 2GM/c^2 \sim 14,4$ billion light-years

B) *Isotropy and Spin:* We assume that the violation of isotropy will not be detectable because of the extremely low angular velocity. In fact no complete rotation will be passed when arriving at the event horizon. Spin results from a radial velocity vector field describing the expansion of our universe and that is not constant over time, but has a derivative at time *NOW* that equals MOND's lower limit radial acceleration. The effect will be that there ist no need for dark matter at all (see conclusion E). For details on this concept of radial velocity vector field, see "On Kip Thorne's limit for rotation of black holes".

C) *Redshift of light* from distant objects generally will be composed of:
1) Redshift because of expansion of space
2) Redshift resulting from gravity
3) Red- and Blueshift because of Doppler effects.

ad 1): The redshift *factor* $\lambda_{obs}/\lambda_{em}$ (λ_{obs} being the observed wavelength and λ_{em} the emitted one) due to expansion of the universe according to the model calculates to:

$F_e(r) := \frac{a(now)}{a(then)} := \frac{\frac{r_0}{d(r_0)}}{\frac{r}{d(r)}}$ with now: = $t_0 = r_0/c$ being the age of the universe from our point of view and a(t) being the scale factor r/d(r) using r=ct.

Some calculated values:

Age (r) [ly]		redshift factor due to expansion
9.702.000.000	*NOW*	1,000
9.043.000.000		1,048
1.846.500.000		2,570
1.589.600.000		2,779
1.148.181.000		3,287
886.070.000		3,753
811.970.000		3,924
608.360.000		4,544
8.873.700		37,891

The last value corresponds to CMB. Note that the redshift factor of 1093 will only finally result by multiplication of all redshift factors. The model yields the time of recombination to 8.873.700 years. But in the event-horizon-model this results because of a massive blueshift Doppler factor of exactly 0,5 corresponding to a rate $\frac{v}{c}$ of 0,6. Note, that the ratio $\frac{9702\ Mio.}{8{,}874\ Mio}$ is exactly 1093, the redshift factor for the microwave background. We will come back to this later on, when comparing the age of some objects in standard-model versus event-horizon-model. Integrating other causes for redshift such as gravity in the event-horizon-model results in a lower age of our universe. The opposite is true for the oldest quasars (see table below). So evolution of the universe since CMB took place in shorter time than predicted by the standard model.

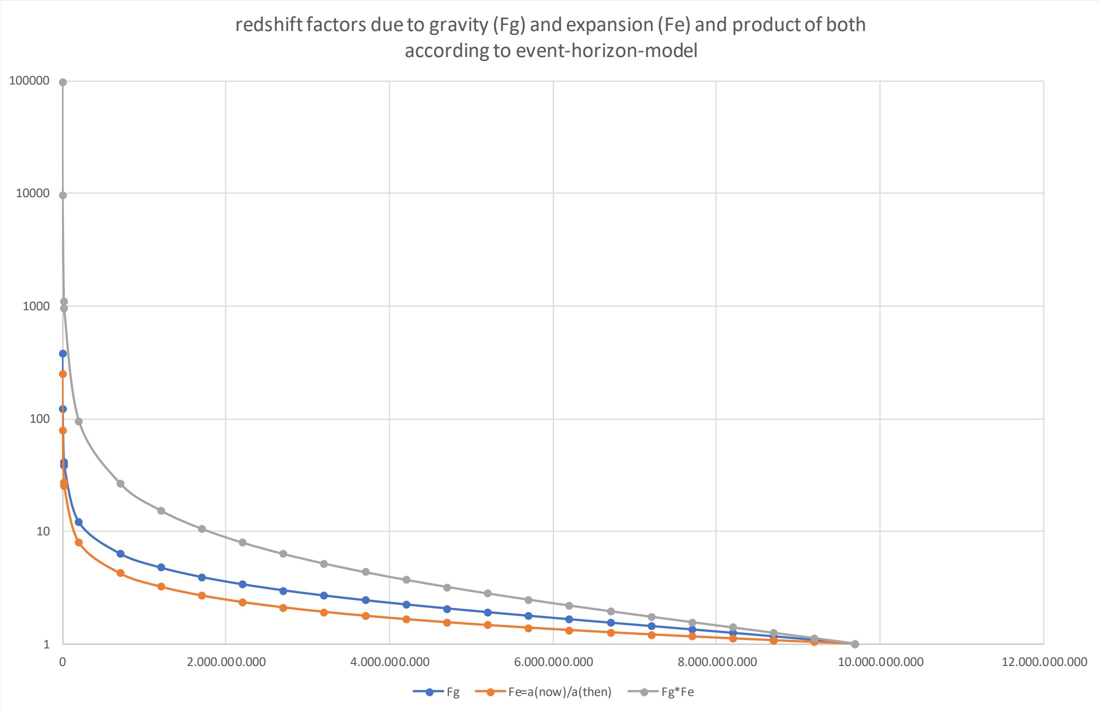
ad 2) The redshift factor due to gravity cannot be neglected and results according to the formula (see Wikipedia: https://de.wikipedia.org/wiki/Rotverschiebung) usually applied for the outer space of the event horizon and in the event-horizon-model used also for the inner space, taking into account that observer and emitter have to be replaced because of our reverse film:

$\lambda_{obs}/\lambda_{em} = \sqrt{\frac{1-\frac{r_S}{r}}{1-\frac{r_S}{r_0}}} = \sqrt{\frac{\frac{r_S}{r}-1}{\frac{r_S}{r_0}-1}}$ with Schwarzschild radius r_s and r_0 the radius of the observer (our location now) and r the radius corresponding to the emitter. For the ages in the above table we get the following redshift factors:

Age (r) [ly]		redshift due to gravity
9.702.000.000	*NOW*	1,000
9.043.000.000		1,105
1.846.900.000		3,736
1.589.600.000		4,068
1.148.181.000		4,868
886.070.000		5,595
811.970.000		5,861
608.360.000		6,821
8.873.700		57,692

The last value corresponds to CMB (see above).

One may notice that the redshift factors due to expansion and due to gravity are quite similar. The next diagram shows their behaviour.



Interpretation: All the models that do not make use of redshift due to gravitation assume that redshift totally is based on expansion of space (if we neglect Doppler effects for special objects such as CMB). Therefore *change* of distances will be assumed to be larger than in event-horizon-model.

ad 3): Doppler effects may not be neglected. The reason is, that at recombination phase the event-horizon-model states that a gigantic explosion happening then, leading to a blueshift Doppler-factor of exactly 0,5. Such a blueshift corresponds to a ratio $\frac{v}{c} = 0{,}6$ of escape velocity v (c being speed of light) using the formula for relativistic doppler effect D_b (E. Daw - Lecture 6 - The relativistic doppler shift of light, 2011): $D_b = \gamma*(1-\beta*\cos\alpha)$ with $\beta = v/c$ and Lorentz factor γ and α being the angle between the flight path of the particle and the line of sight (in our case of CMB, α=0°).
Also, for distant quasars doppler blueshift may play an important role when determining the age of the objects because blueshift factors have to be considered. Since such a blueshift factor would be less than 1, the age of an object would be less, counted from big bang, when taking into account this factor. Nowadays cosmologists interpret quasars as super massive black holes located in centers of galaxies. The accretion disks near the center of such galaxies eject jets which particles reach relativistic speeds. The part of the velocity vector in our direction in its magnitude is the larger the smaller the angle α is between jet and our line of sight. Note however that the relativistic doppler factor is not zero when α = 90°. The so-called transversal doppler factor equal to the Lorentz factor. See appendix 2 for more information.

The overall redshift factor will be the product of all the 3 factors (here F_d =1 for red- and blueshift corresponding to doppler effects): $F = F_e * F_g * F_d$ and therefore redshift z will be z = F-1. The next table shows some calculated values of redshift for the event-horizon-model (ages with respect to the comoving distance to big bang):

object	age according to Event-Horizon-Model [years]	redshift measured	age with respect to standard model [years]
CMB	8.873.700 years due to additional *blue shift Doppler factor of 0,5*	1092	400.000 years
galaxy and quasar *UDFj-39546284*	1.590.000.000 years (if Doppler-blueshift-factor would be 0,8: 1,3 billion years)	10,3	580.000.000 years
galaxy and quasar *UDFy-38135539*	1.850.000.000 years (if Doppler-blueshift-factor would be 0,8: 1,5 billion years)	8,6	700.000.000 Jahre
Quasar 3C 273	9.043.000.000 years (if Doppler-blueshift-factor would be 0,8: 8,0 billion years)	0,158	11,7 billion years
NOW from our point of view (t_0)	9.702.000.000 years	0	13.800.000.000 years

Note:

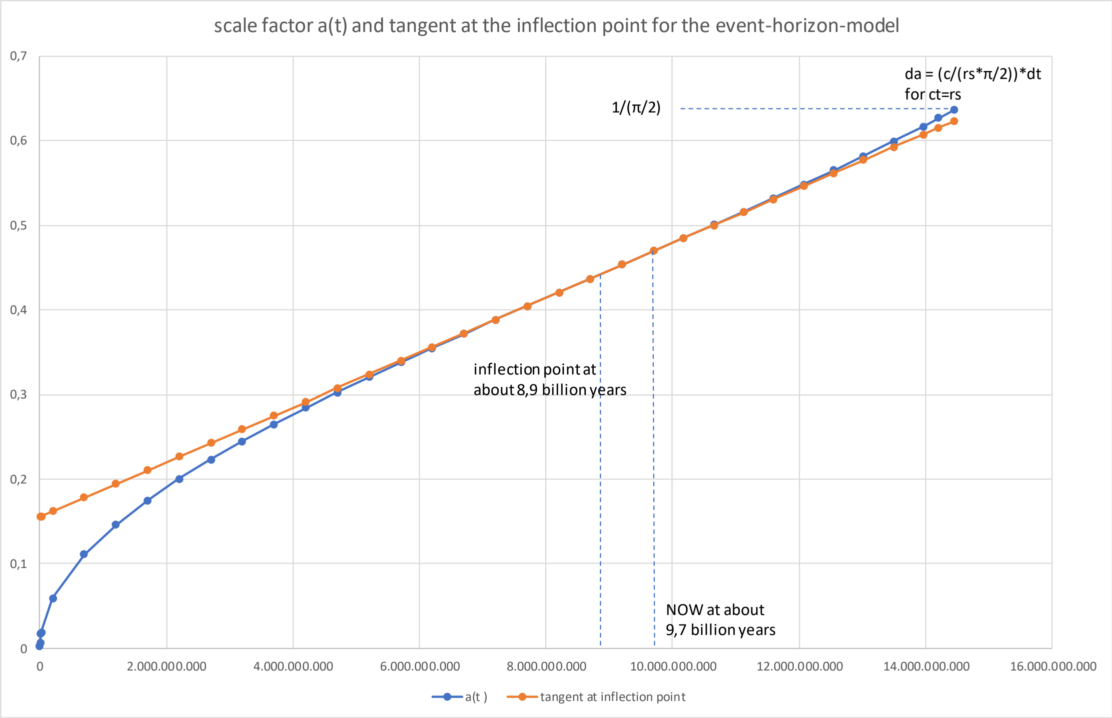
1) For CMB we get a ratio $\frac{r(NOW)}{r(CMB)} = \frac{9702\ Mio.}{8{,}874\ Mio} = 1093$, which is exactly the measured redshift factor of microwave background.
2) If one proposes a doppler blueshift factor of 0,8 for a far distant object, the distance of this object from us increases by about 300 million light years. For distances around 1 billion light years the additional distance would be ~1 billion light years.

So the main differences between event-horizon-model and standard-model in calculation of distances are

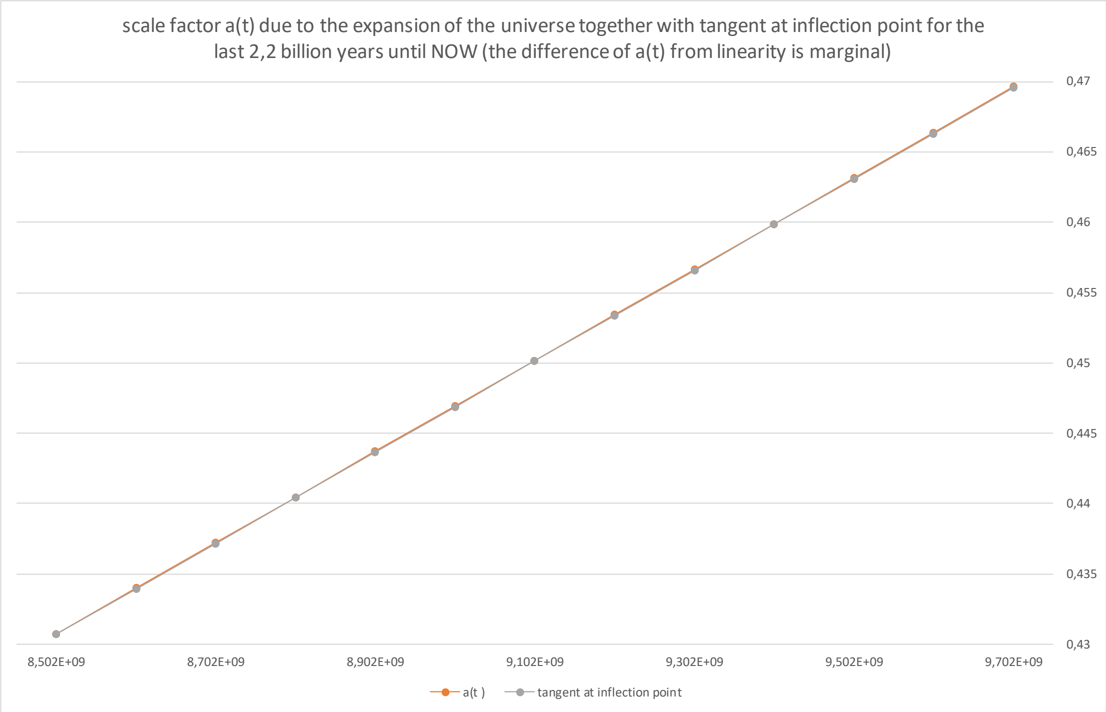
- that objects in the event-horizon-model are not as near to big bang for very distant objects
- that objects being near to us in standard model are nearer in event-horizon-model

If we define the Hubble-parameter as H(t) = ȧ(t)/a(t)[9], using a(t) = ct/d(ct), we get for the value corresponding to *NOW* H_0: = $H(t_0)$ ~ 67,7 km/s/Mpc. This value lies in the range for the Hubble-parameter according to measurements done by the Planck space telescope (see (Wikipedia - Hubble-Konstante, 2018)). The diagrams to come show trends of a(t) and H(t) respectively. At first the course of the function a(t):

[9] A short calculation shows ȧ(t)/a(t) = $\frac{1}{t} * \frac{r_s}{\mathrm{ct}} * \mathrm{a(t)} * \arctan\left(\sqrt{\frac{\mathrm{ct}}{r_s - \mathrm{ct}}}\right)$

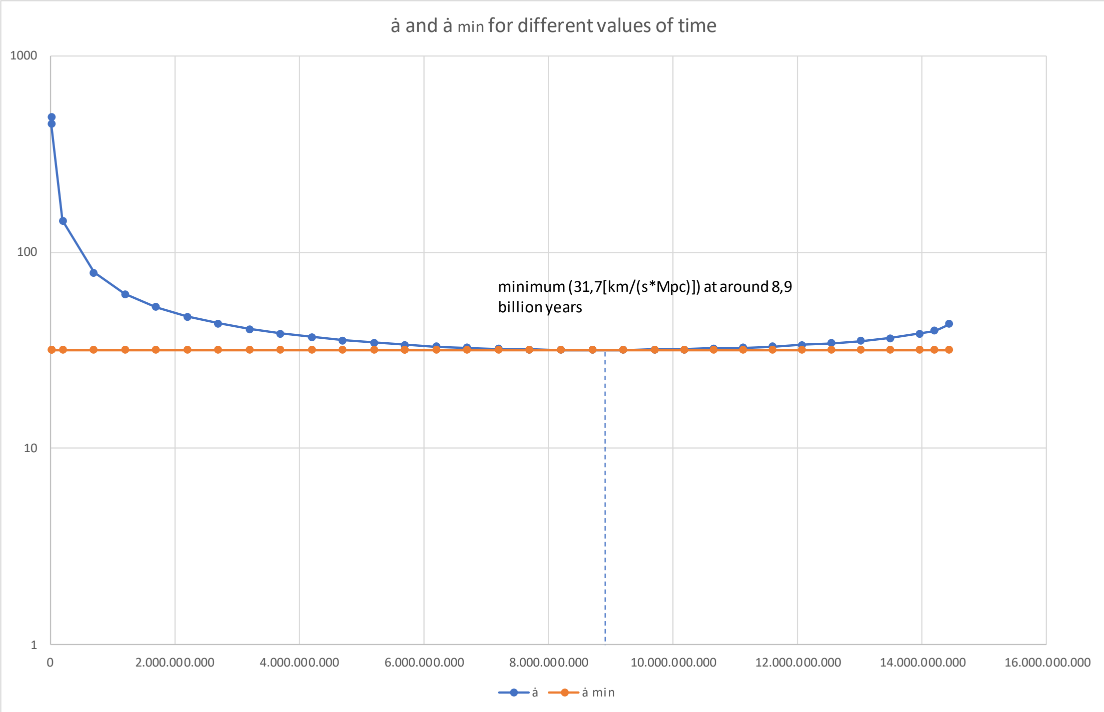


The curve for the scale factor has a point of inflection at about 8,9 billion years and increases to a value of 1/(π/2) at the event horizon. This means that the expansion of the universe decreased until 8,9 billion years since big bang and then increased. The curve for the last 2,2 billion years is shown in the next diagram.

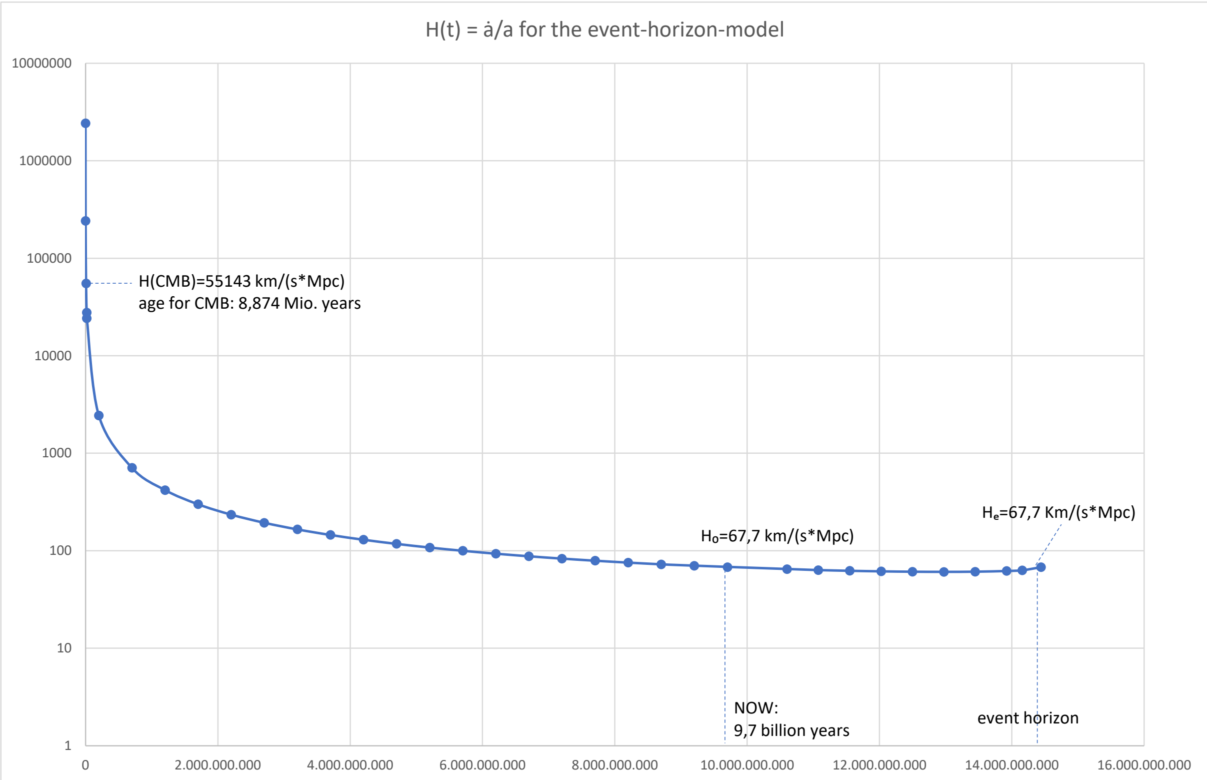


As you see the deviation from constant expansion is marginal.

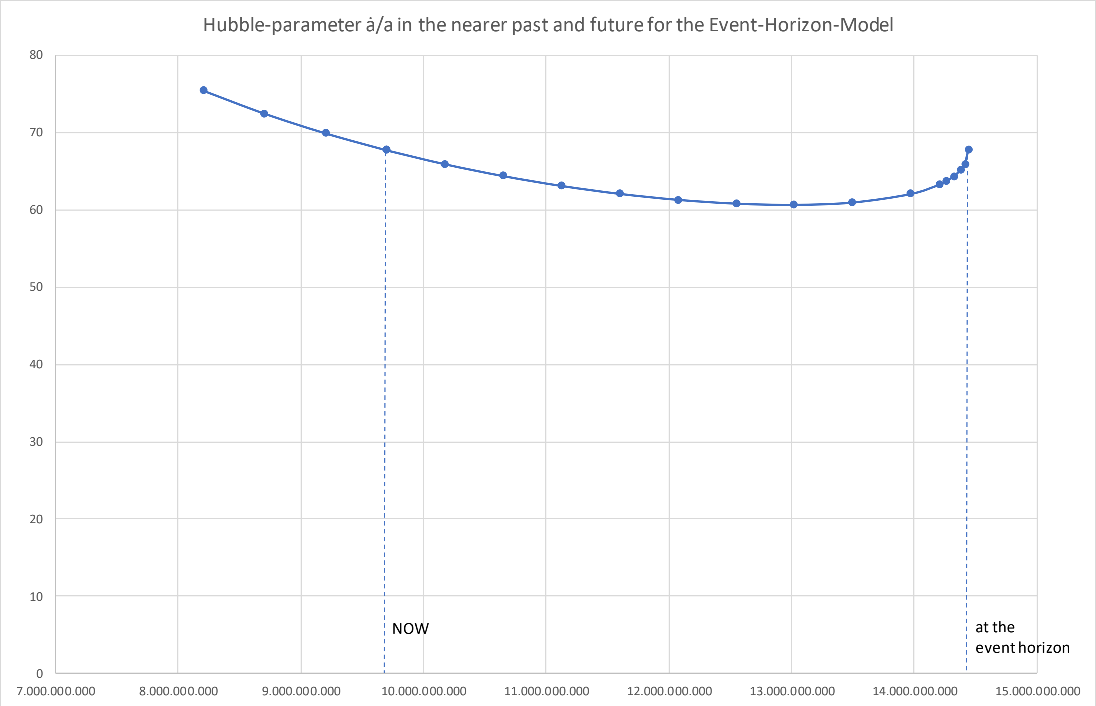
Next the curve for the derivative ȧ(t) of the scale factor [km/(s*Mpc)]:



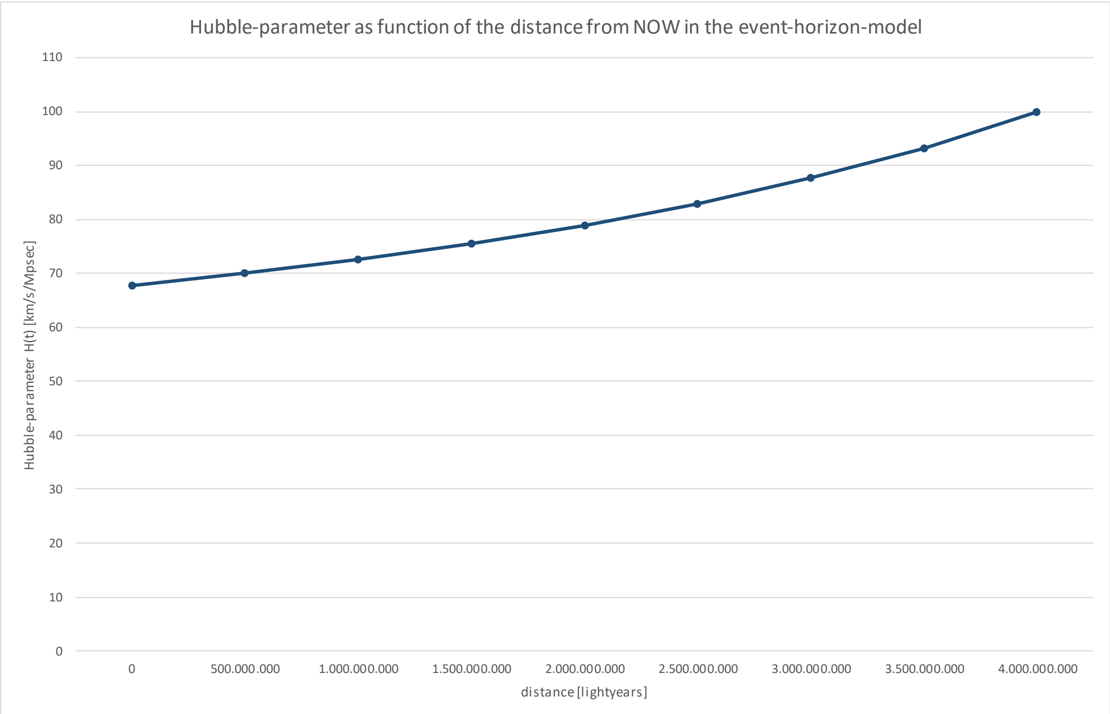
As a result we get the curve for the Hubble-parameter H(t) = ȧ(t)/a(t) in units of [km/(s*Mpc)] and with logarithmic scaling on the H-axis:



The same curve zoomed to our near-by environment (normal scaling on H-axis):



One can see that H(t) decreases till an age of about 13 billion years and from then on increases to end up at the event horizon with unlimited gradient at a value that is almost exactly the one of today. The diagram to come schows the Hubble-parameter as a function of the distance from *NOW* for the near past.



By the way H(t) grows unlimited when approaching the big bang. For instance we would get values of about 10^{140} at ~$5*10^{-44}$ s after the big bang and about 10^{124} km/(s*Mpc) at ~10^{-35} s after the big bang.

D) In the event-horizon-model there was no *inflation*. Inflation was introduced by Alan Guth in order to get rid of the horizon problem, originally because of the problem of homogenity with respect to horizons at the beginning not overlapping sufficiently. In the event-horizon-model the universe is asymptotically homogeneous because of approaching the event horizon.

E) There is no *dark matter*. Instead of the concept of dark matter the event-horizon-model suggests a principle we call *Mach's minimal principle* (in honour to Ernst Mach), stating that *no radial acceleration value of any rotational system in the universe may fall below the actual limiting radial acceleration value*. This actual limiting radial acceleration turns out to be the limit radial acceleration of MOND. For scales of galaxies and clusters of galaxies we find a modified Newtonian law for gravity.

For non-relativistic rotational velocities in rotational systems we postulate the following modified law for the radial acceleration $a_0(r)$ (only magnitudes are used):

$$a_0(r) = \frac{G*M(r)}{r^2} + \frac{G*M_U}{2\pi {r_0}^2} = \frac{G*M(r)}{r^2} + \frac{r_s*c^2}{4\pi {r_0}^2} \text{[10]} = \frac{v^2}{r} \qquad (1)$$

where the second summand denotes some kind of gravitational feedback from the universe on rotational systems, given by the derivative of a radial velocity vector field, describing the expansion of our universe (see "On Kip Thorne's limit for rotation of black holes"). M(r) denotes the mass of the system inside radius r, G the gravitational constant, M_U the total mass of the universe (with respect to our atomic film), r_s being the Schwarzschild radius of our universe, r_0 the radius corresponding to *NOW* in comoving distances and v = v(r) being the rotational velocity magnitude.

For the event-horizon-model the second summand $\frac{r_s*c^2}{4\pi {r_0}^2}$ calculates to $1{,}16*10^{-10}$ m/s^2.

This value is very close to the limit acceleration α_0 of MOND. Note however, that this limit radial acceleration is not a constant but varies with time (similar to the Hubble-parameter). The limit radial acceleration over time is shown in the diagram below.

One may recognize that for far distant galaxies the value of the limit radial acceleration was bigger than now (i.e. for galaxies of age 2 billion years with respect to big bang the value was twenty times today's value). On the other hand one has to consider that far distant galaxies probably had significantly smaller diameter and cores of larger mass.

For the magnitude of rotational velocity depending on radius r with respect to the center of the rotational system we get:

$$v(r) = \sqrt{\frac{G*M(r)}{r} + \frac{G*M_U*r}{2\pi {r_0}^2}} = \sqrt{\frac{G*(M(r) + \frac{M_U*r^2}{2\pi {r_0}^2})}{r}}$$

i.e. compared to the Newtonian part $\sqrt{\frac{G*M(r)}{r}}$ according to mass M(r) we get some kind of additional *virtual mass* $M_v(r) := \frac{M_U*r^2}{2\pi {r_0}^2}$, which value may be neglected near the center of the rotational system, but gets dominant from some distance to the center on. $M_v(r)$ stands for the so-called *dark matter*.

[10] using $r_s = \frac{2G*M_U}{c^2}$ Note, that this function $\frac{r_s*c^2}{4\pi {r_0}^2}$ for minimum radial acceleration may only be an approximation of the real function in an environment of *NOW*. Otherwise we could determine the radial velocity vector field by simple integration.

See appendix 3 for an example of using the formulas above in order to calculate the rotational velocity of the sun in our galaxy.

For a far distant rotational system G the above formula for $a_0(r)$ has to include the value r_G corresponding to the age t_G of the rotational system G with $r_G = c*t_G$ instead of r_0. The item $a_0(r)$ then has to be replaced by $a_G(r)$ for consistency.

Since v^2 may not get negative, we can derive:

$v \geq \sqrt{\frac{G*M_U*r}{2\pi r_0{}^2}}$ =: v^T (minimal rotational velocity).

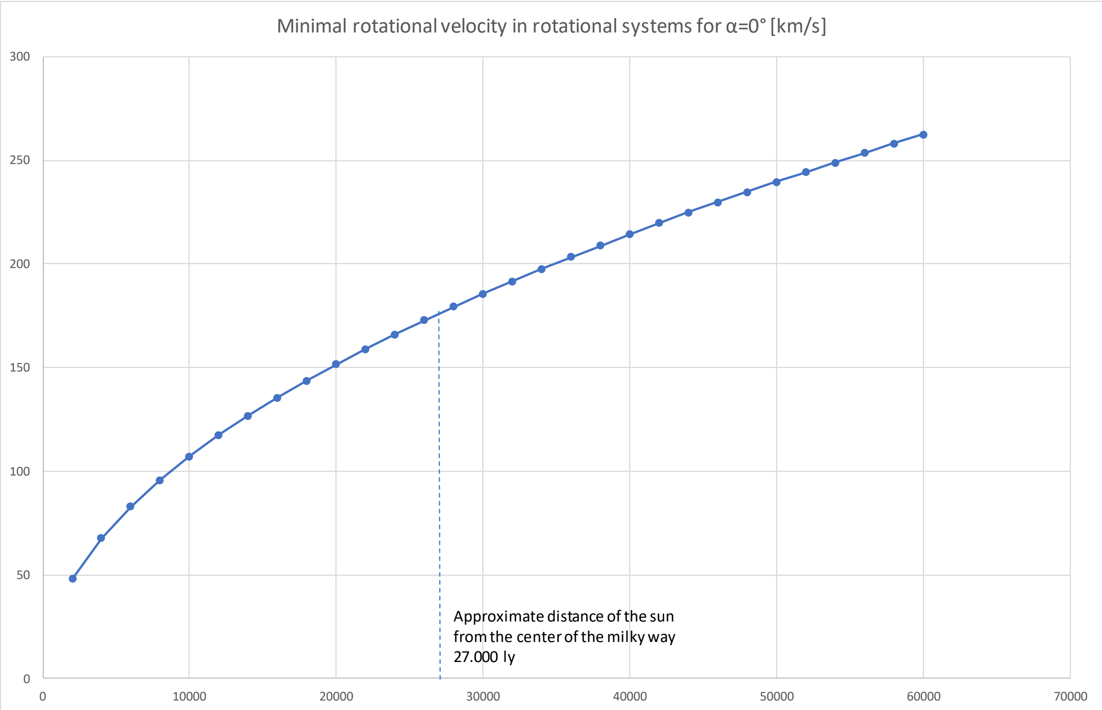
For $r_G = r_0$ we get $\mu_0 := \sqrt{\frac{G*M_U}{2\pi r_0{}^2}} = \sqrt{\frac{r_S*c^2}{4\pi r_0{}^2}}$ equal to

$1{,}08*10^{-5}\frac{\sqrt{m}}{s}$, thus $\mu_0 \approx 1{,}05\frac{km}{s*\sqrt{ly}}$.

This means: $v \geq \mu_0 * \sqrt{r}$ with r being the distance from the rotational center in light-years (ly).

This relation shall be valid independently of the rotational system but only near this system. For more distant objects one has to take into consideration that r_0 getting smaller the more distant objects are.

The next diagram shows the minimal rotational velocity of rotational systems nearby.



Milky Way:

Measured data for rotational velocities in our galaxy as presented in (RWTH Aachen, Laura Baudis, 2007) on the last slide, are compliant to the above curve.

In order to estimate the maximal amount of „dark matter“ within the galaxy’s disk we can calculate the upper limit at a radius of 100.000 light-years:

$M_V(r) = \frac{M_U * r^2}{2\pi {r_0}^2} \sim \frac{\mathbf{0{,}92} * 10^{53} * 100.000^2}{2\pi * (9{,}7 * 10^9)^2} kg$ ~ 1,55*10^{42} kg. This is equivalent to about 780 billion solar masses.

Almost orthogonal to the disk there is a set of dwarf galaxies rotating around the galaxy nearly within a disk, and at increased velocity compared to just Newtonian behaviour (Welt der Physik: Satellitengalaxien kontra Dunkle Materie, 2009). The dark-matter-hypothesis postulates a random distribution of orbital planes of the satellite galaxies. Taking the Large Magellanic Cloud as a representative of the satellite galaxies of the Milky Way, we can calculate the following values for virtual masses and rotational velocities using the measured distance of 160.000 light years (Wikipedia: Magellansche Wolken, 2018):

VM [ʘ] ≈ 2,1*10^{12}

v(r) [km/s] ≈ 458

Herein the baryonic mass of the Milky Way inside the 160.000-ly-radius was assumed to count to 300 billion solar masses.

Bullet-Cluster:

The Bullet cluster consists of two clusters of galaxies that penetrated each other leaving behind a cloud of merged gas between the now separating clusters. Although the mass concentrates in the cloud of gas the Bullet-cluster shows lensing effects primarily in the separating clusters. This is noted to be a counterexample to MOND theory and an indicator for the dark matter hypothesis. The event-horizon-model states that the virtual masses add only to rotational systems but not to the cloud of gas. So the observed lensing effect may be explained without using the concept of dark matter.

Solar system:

For very small radii witin rotational systems like the solar system the amounts of virtual masses are tiny compared to the mass of the sun. For the radius of 150 million km which approximately is the distance of the earth to the sun, we get a maximum virtual mass of 4,1*10^{22} kg. This is comparable to the mass of the moon (7,35*10^{22} kg) and corresponds to 2*10^{-8} solar masses. For an average radius of Pluto we would get a virtual mass of 0,000033 solar masses.

3 Falsification

3.1 Limit radial acceleration in galaxies of the universe

The event-horizon-model predicts that the radial acceleration of arbitrary rotational systems may not fall below a limit radial acceleration given by formula (1) of 2.3/conclusision E corresponding to Mach's minimal principle. This may be verified or falsified by observation of cosmic rotational systems.

3.2 Mimimal rotational velocities in galaxies

The event-horizon-model predicts that in our galaxis and nearby galaxies the rotational velocity of stars and satellite galaxies may not fall below a limit rotational velocity given by $\mu_0 * \sqrt{r}$ with r being the distance from the center in light-years (ly), $\mu_0 = 1{,}07 \frac{km}{s * \sqrt{ly}}$. This may be verified or falsified by observation of galaxies in distances of up to 1 billion light years.

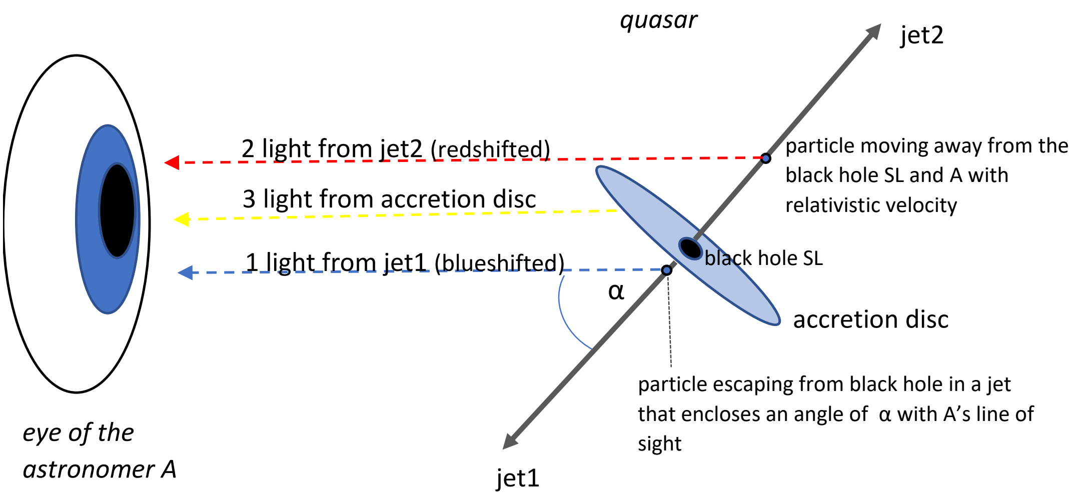
Appendices

A1: Doppler effects in observations of supernovae Ia

See "On Doppler effects of supernovae Ia".

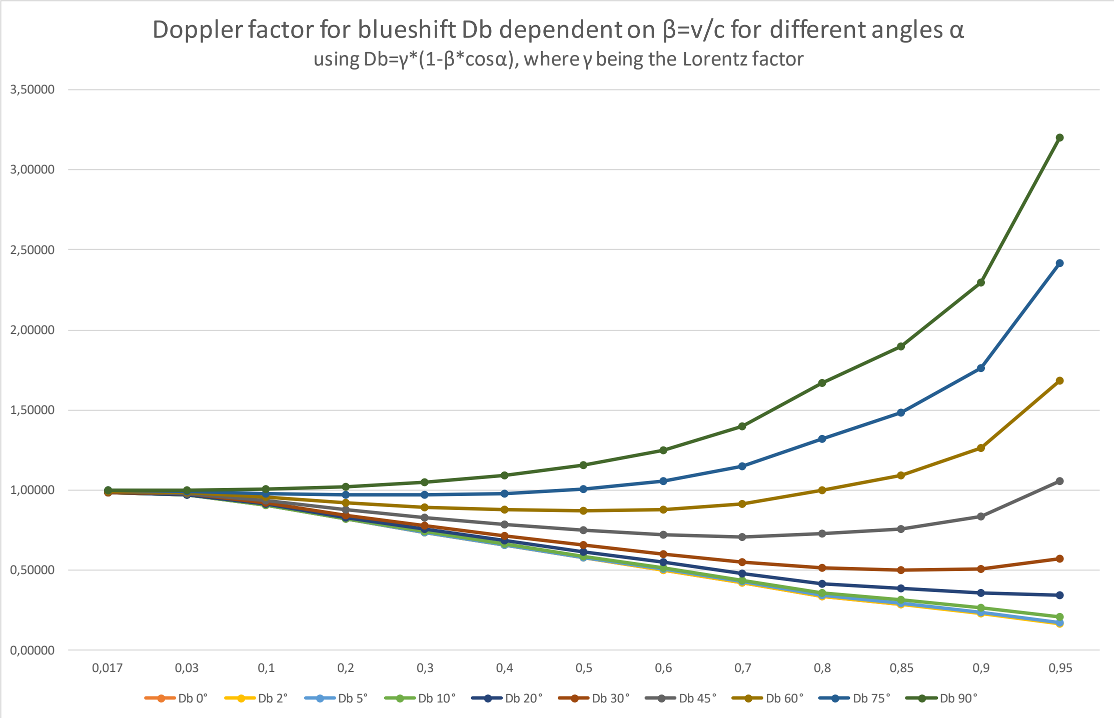
A2: Quasars and Doppler blueshift and redshift

The picture to follow illustrates a general model of quasars.



Because of relativistic velocities of particles in jets of quasars, Doppler effects cannot be ignored when using redshift of light of far distant quasars in order to derive distances. Merely calculating distances according to redshift due to expansion of space would result in quite different values for light of jet1 and the accretion disc. If α is quite small then the light of jet1 might be too bright so that we cannot see light of the accretion disc at all. The Doppler factor is $D:=\lambda_{obs}/\lambda_{em}$, λ_{obs} being the observed wavelength and λ_{em} the emitted one. The redshift z we get from: $z+1=D_r$. The Doppler factor D_b to blueshift is: $D_b = \gamma*(1-\beta*\cos\alpha)$ with $\beta = v/c$ and Lorentz factor γ. Similarly for redshift we get: $D_r = \gamma*(1+\beta*\cos\alpha)$.

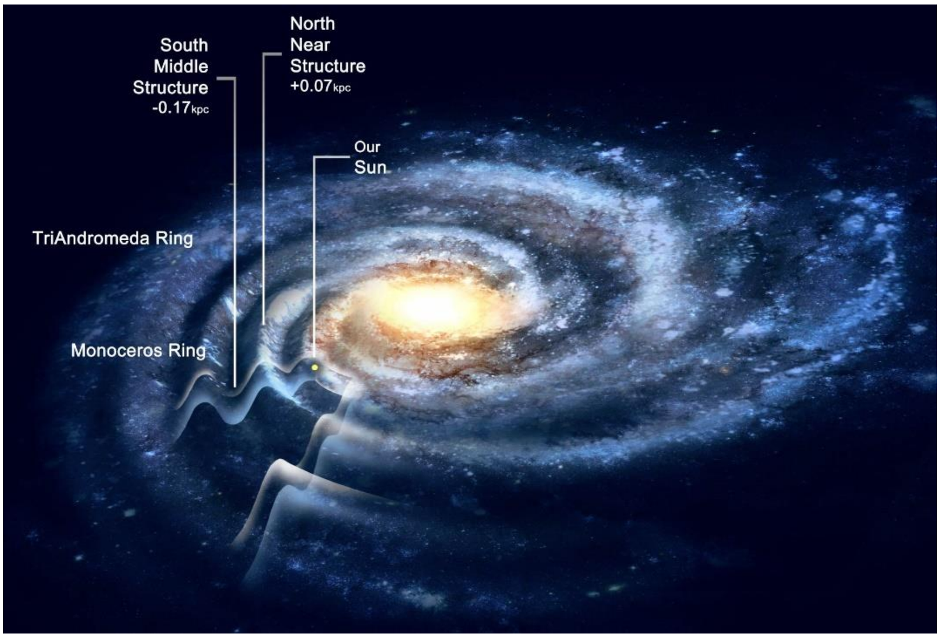
The next diagram shows D_b depending on β for selected angles α:



In the event-horizon-model the time from big bang to formation of the first galaxies is larger then the period is in the CDM-Standard-Model. But because of Doppler blueshift far distant quasars may be further away than expected due to mere redshift from expansion of space.

A3: Rotation velocity of the sun in our galaxy Milky Way

The next picture has been created at Rensselaer Polytechnic Institute. It illustrates our home galaxy Milky Way according to actual observations. The sun herein is placed into one of the spirals at about 27.000 light-years away from the center of the galaxy.



Due to Mach's Minimal Principle the radial acceleration of the whole universe influences any rotational system like galaxies or clusters of galaxies. Since rotational velocities within a galaxy and near its border are not relativistic in magnitude, the rotational velocities satisfy a modified Newtonian law according to the event-horizon-model. If r is a definite radius and M(r) denotes the baryonic mass of the galaxy inside the sphere given by r, for an object at radius r from the center of the galaxy we would get for the radial acceleration a(r):

$a(r) = \frac{G*M(r)}{r^2} + \frac{G*M_U}{2\pi {r_0}^2} = \frac{v^2}{r}$ (compare 3.2/conclusion E). Therefore:

$$v(r) = \sqrt{\frac{G*M(r)}{r} + \frac{r*G*M_U}{2\pi {r_0}^2}} = \sqrt{\frac{G*(M(r) + \frac{G*M_U*r^2}{2\pi {r_0}^2})}{r}}$$

i.e. compared to Newton's formula $v(r) = \sqrt{\frac{G*M(r)}{r}}$ we have an additional virtual mass $M_v(r) := \frac{M_U*r^2}{2\pi {r_0}^2}$.

The value of the resulting additional radial acceleration $\frac{G*M_U}{2\pi {r_0}^2}$ for α_0=0 according to the event-horizon-model calculates to $1{,}16*10^{-10}$ m/s^2.

For calculation of the rotational velocity of the sun in our galaxy we assume the following:

The orbit of our sun in the galaxis projected to the galactic plane (the sun crosses the galactic plane in its loop around the center every approximately 38 million years), is assumed to be nearly circular with a radius of about 27.000 light-years. The mass of the galaxy inside this radius shall be estimated at 80 billion solar masses *(=1,59*10^{41} kg).* Thus we can calculate:

VM [billion $M_\odot$]	57
v(r) [km/s]	267

Originally the value of the rotational velocity of our sun in the Milky Way was calculated to be 222 km/s. Recent measurements (see (Milchstrasse massereicher als gedacht, 2009) and (Wikipedia-Milchstraße, 2018)) yielded a value of 267 km/s.

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