This is an excerpt of my main treatise http://henk-reints.nl/astro/HR-on-the-universe.php.
Any unsolved references below are found right there.

The Hubble–Lemaître law

As predicted by Georges Lemaître[1] and discovered by Edwin Hubble[2], nearly all galaxies move away from us with a *velocity* proportional to their *distance*:

$$v_H = H_0 \cdot D \qquad [29]$$

where H_0 is the *Hubble constant,* v_H the *velocity* in the Hubble flow (which I will call *Hubble velocity*), and D is the *distance* to the object.

This law implies that all objects in te universe once must have been all together at the same location, as a very dense thing containing all matter in the universe. In accordance with the Dutch word for the universe: *heelal* ("whole all"), I call this inital blob of primitive matter (Dutch: klodder oermaterie) the *IniAll*. And since there exists no observational evidence whatsoever, I do not look further back in *time* than this *IniAll* and I do not ask the question of how it came into being. In other words: I do not look back towards the singularity[3] that would have been the true start of the universe. I don't even know if the universe indeed "came into being". As cited in the introduction, Isaac Newton wrote: hypotheses non fingo, *I feign no hypotheses, I contrive no concoctions.* Neither do I. No assumptions unless supported by observed phenomena. In Dutch: ik zuig niks uit mijn duim, ik pluk niks uit de lucht.

The *time* passed since the *IniAll* is called the *Hubble time*, which equals the reciprocal of the *Hubble constant*:

$$t_H = 1/H_0 \qquad [30]$$

which is to be considered the age of the universe. This *time* multiplied by the *speed of light* yields the *Hubble distance*:

$$D_H = c \cdot t_H \qquad [31]$$

Since no object can ever have travelled faster than light, the *Hubble distance* yields the size of the universe.

THE HUBBLE–LEMAÎTRE LAW IMPLIES THE UNIVERSE IS FINITE. [32]

Note: Olbers' paradox[4] (if the universe were infinitely and homogeneously filled with light sources, it could not be dark at night) also implies the universe is finite, which was already recognised by Johannes Kepler in 1610 (in a letter to Galileo Galilei[5]).

From the above we can easily see:

$$\beta_H \equiv \frac{v_H}{c} = \frac{D}{D_H} \equiv \rho_H \qquad [33]$$

which is the dimensionless form of the Hubble–Lemaître law. Note: right here, ρ is used for dimensionless *distance*, but further below also for *density*. The context should then clarify what is meant.

On https://en.wikipedia.org/wiki/Hubble%27s_law various values of the *Hubble constant* are given, even recent measurements with non-overlapping tolerances... I choose a value of:

$$H_0 = 69.84 \text{ km/s/Mpc} \qquad [34]$$

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[1] G. Lemaître, Discussion sur l'évolution de l'univers, 1927

[2] Edwin P. Hubble, "A relation between distance and radial velocity among extra-galactic nebulae", *Proc. Natl. Acad. Sci. USA* 15, 168–173 (1929).

[3] S.W. Hawking & R.Penrose, The singularities of gravitational collapse and cosmology, Proceedings of the Royal Society, (1970-01-27), DOI: 10.1098/rspa.1970.0021

[4] https://en.wikipedia.org/wiki/Olbers%27_paradox

[5] https://www.huffingtonpost.com/mario-livio/who-first-wondered-why-is_b_3676160.html

which yields a *Hubble time* of almost exactly:

$$t_H = 14.00 \text{ Ga} \quad [35]$$

This is just a choice within the rather wide range of plausible values, made for the ease of calculations.

A big mistake

Consider an object at say 10 Gly from here. Then, according to [33], its *velocity* equals: $v = \frac{10}{14}c$. Its light needed 10 Ga to reach us, so it was emitted when the object was $14 - 10 = 4$ Ga old. But how did the object arrive at a *distance* of 10 Gly during a *time* of 4 Ga at a *velocity* of $v = \frac{10}{14}c$? Newton's law of inertia, together with the neglection of gravitational slowdown according to [28], tells this velocity must have been practically constant all *time*. Any contradictory statement must alway be rejected because of the principle of explosion, but common cosmology seems to take this inconsistency for granted, which I consider a big mistake. [36]

Ex falso sequitur quod libet = *from falsehood follows anything you like*.

I think this mistake is the root cause of the (to my opinion wrong) idea of the unobservable part of the universe and the horizon problem, which ultimately lead to the *inflationary universe* theory by Alan Guth[6]. This is an "*if <brainchild> then it would ...*" theory in which he feigned a hypothesis, a fiction, to tackle the non-realistic horizon problem that arises from [36] and the also not existing flatness of the universe (see page 35 and further). It assumes *velocities* very heavily tresspassing the *speed limit of light* by stating that it was the metric itself that expanded and then it would not have to obey the *speed limit of light*. But Einstein never ever mentions any cause of a *velocity*, and any *distance change over time* is a *velocity*, whatever caused it, be it the metric itself or whatever. Based on observed phenomena, the only plausible statement is that not any *velocity* can exceed the *speed of light*.

Corrected form of the Hubble–Lemaître law

Let's do some straight forward proper math. I define the *time* since the big bang ("BB")

as:	t_{bb}	[37]
Assume a light source at an *emission distance*:	D_e	[38]
The *light travel time* from that *distance* is:	$t_L = \frac{D_e}{c}$	[39]
Net *object travel time* since BB to that place is:	t_{obj}	[40]
The light is observed right now, so it must be that:	$t_{obj} + t_L = t_{bb}$	[41]
so:	$t_{obj} = t_{bb} - t_L = t_{bb} - \frac{D_e}{c}$	[42]
which yields an *object velocity* of:	$v_H = \frac{D_e}{t_{obj}} = \frac{D_e}{t_{bb} - \frac{D_e}{c}} = \frac{c \cdot D_e}{ct_{bb} - D_e}$	[43]
or, with [33]:	$\beta_H = \frac{D_e}{ct_{bb} - D_e}$	[44]
This has a Taylor series expansion of:	$\beta_H = \frac{D_e}{ct_{bb}} + \left(\frac{D_e}{ct_{bb}}\right)^2 + \left(\frac{D_e}{ct_{bb}}\right)^3 + \cdots$	[45]
Comparison with [33] yields that in first order:	$\frac{D_e}{ct_{bb}} = \rho_e$	[46]
so:	$ct_{bb} = D_H$	[47]
and:	$t_{bb} = t_H$	[48]

[6] Alan H. Guth, Inflationary universe: A possible solution to the horizon and flatness problems, Phys.Rev.D 23, 347, published 1981-01-15

This means [44] becomes: $\beta_H = \frac{D_e}{D_H - D_e} = \frac{\rho_e}{1-\rho_e}$ [49]

or: $\rho_e = \frac{\beta_H}{1+\beta_H}$ [50]

According to [11], this (dimensionless) *emission distance* equals the *light travel distance*, so:

$\rho_L = \rho_e$ [51]

and using dimensionless *time*: $\tau = \frac{t}{t_H}$ [52]

we can easily see that: $\tau_L = \rho_L = \frac{\beta_H}{1+\beta_H}$ [53]

It is of course obvious that the dimensionless *light travel time* equals the dimensionless *light travel distance*, since $c = 1$ in dimensionless quantities. During this *light travel time*, the object has kept moving in the Hubble flow, which implies that

its *current proper distance* equals: $\rho_P = \beta_H$ [54]

The *speed limit of light* says: $\beta < 1$ [55]

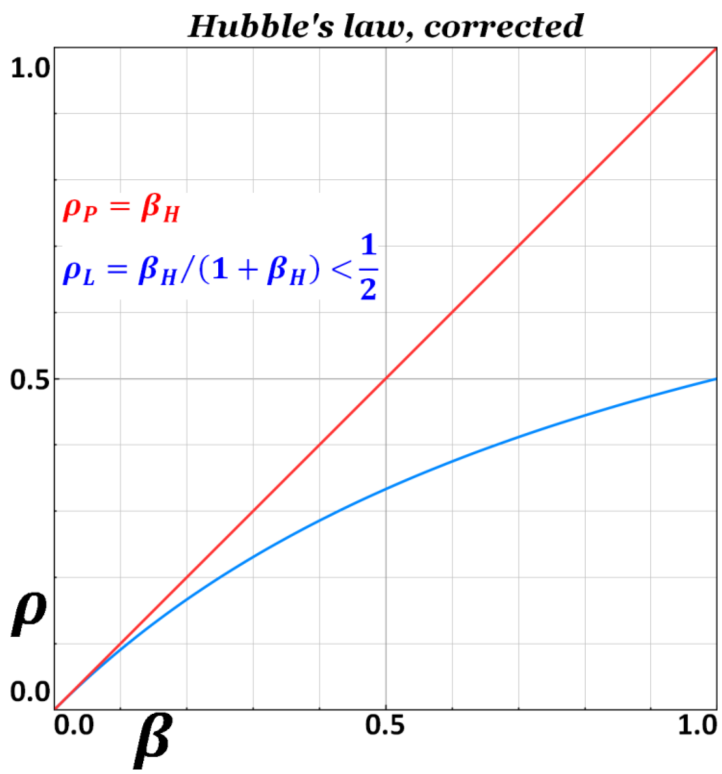
which implies: $\tau_L < \frac{1}{2}$ [56]

as well as: $\rho_L < \frac{1}{2}$ [57]

Altogether, the corrected form of the Hubble–Lemaître law is:

- *Light travel time*: $\tau_L = \frac{\beta_H}{1+\beta_H} < \frac{1}{2}$ [58]
- *Light travel distance*: $\rho_L = \frac{\beta_H}{1+\beta_H} < \frac{1}{2}$ [59]
- *Current proper distance*: $\rho_P = \beta_H$ [60]

The value of β_H can for each object be derived from its *redshift*, see further below. Both [58] and [59] apply to a currently observed photon and [60] applies to the light source from which it originates.



Conclusions:

1. both the *lookback time* and the *lookback distance* of any object are at most half the *Hubble time* or *distance* and at the moment of emission of the currently observed light their *age* since the big bang, as measured in our local frame, was at least half the *Hubble time*; [61]
2. what is called *light-travel distance* by conventional cosmology is in fact the *current proper distance*, which equals the *light-travel distance* for a now emitted photon, not a now observed one; [62]
3. no two objects in the universe can have a mutual *distance* greater than the *Hubble distance*; [63]
4. **conventional cosmology is making a BIG mistake!** [64]

Don't agree? Then please tell me were I made my own mistake. I draw my conclusions from observed phenomena without feigning hypotheses such as the mathematically impossible *superluminality* or taking inconsistencies like [36] for granted. And I am doing proper math. The Dutch word for mathematics is wiskunde, a term invented by Simon Stevin (1548-1620). The first syllable: wis, means: sure, certain, and kunde means: skill, knowledge.

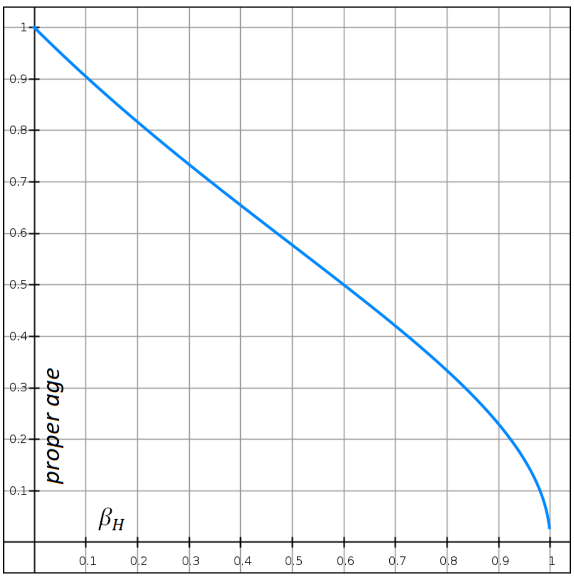
This *maximum lookback time* of half the *Hubble time* (which applies to distant objects) does of course not restrict the *age* of those objects, they can evidently already have existed for a long *time* before emission of the light we now observe. But the light that was emitted earlier than half the *Hubble time* ago already passed us, we've missed it, and we will never ever get another opportunity to observe that light.

For the moment of emission of a photon, we obtain:

Moment of emission: $$\tau_e = 1 - \tau_L = 1 - \frac{\beta_H}{1+\beta_H} = \frac{1}{1+\beta_H}$$ [65]

which is in our local frame. But distant galaxies have a large *Hubble velocity*, causing *time dilation*. We see their *time* run slower, so in order to obtain their *proper age* (since the big bang) in their own *local frame* we must divide [65] by the *Lorentz factor*.

Object's *proper age*: $$\tau'_e = \tau_e \sqrt{1-\beta_H^2} = \frac{\sqrt{1-\beta_H^2}}{1+\beta_H} = \sqrt{\frac{1-\beta_H}{1+\beta_H}} = \frac{1}{\zeta} = \frac{1}{z+1}$$ [66]



proper age vs. *Hubble velocity*

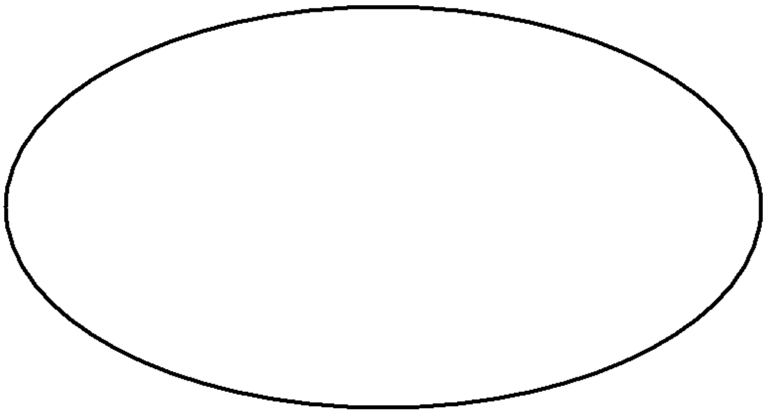
So in spite of this *maximum lookback time* of half the *Hubble time*, we can still observe very young objects and events, thanks to *time dilation*. In their own *time* they are far younger than the first half of the *Hubble time* as measured in our *time*. But very distant objects are not as young as what a linear lookback would yield.

<u>Please note:</u>

This last equation [66] is incorrect. I applied the *Lorentz factor* to a point in *time*, which is not very clever. Please see http://henk-reints.nl/astro/HR-distant-proper-age.pdf for a correct derivation, which may astonish you!

Edwin Hubble

Georges Lemaître



the big bang: no explosion, no background objects,
not red hot, not white hot, but γ-ray hot all around