Shrinking Matter Theory with Variable Speed of Light (SMTwVSL)

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1) The "Shrinking Matter Theory with Variable Speed of Light" (SMTwVSL)

1.1) Abstract

This is an alternative theory of the evolution of the universe, which considers the possibility of the evolution of matter over time, which allows the variation of parameters that we consider constant, but which can vary so slowly over time, which is difficult in our lifetime that we notice any change.
The two main constants that govern the behavior of the universe are the speed of light and Planck's constant. In this theory we are considering the possibility of the variation of the speed of light, because we know that it is very sensitive to variations in medium, which can be the key to solving the problems found in the theory of the expansion of the universe, thus explaining observed redshift emissions from deep space objects, without the need for its expansion.
The SMTwVSL and the expanding universe theory are equivalent. If we make our world as the reference frame, the universe should expand. If we make the universe as the reference frame, matter should shrink. Laws of physics work to both theories.
The main difference of the expanding universe and the SMTwVSL is what causes the longer wavelength emissions observed of the deep space objects.
The Doppler shift (redshift) is well known in the expanding theory.
In the SMTwVSL, the universe is the reference frame, so there is not expansion to cause redshift (except in the systemic local movements like rotation, orbits, binary systems, turbulence, ejection, gravitational effect and gravitational falling), so, the longer wavelengths observed are actually longer emission lines due the bigger size of atoms in the past.
If we assume the speed of the light varies along the time and the Planck constant keeps the same value, light speed "C" decreases by the factor of (1+Z)^(-1/3) along the past time.
Then, the classical formula would be: $C_{(f)} = C_{(o)} (1+Z)^{-1/3}$ (I).
(f) is the reference frame in the past.
(0) is our local frame at present.
Z is the redshift.
The factor (1+Z)^(-1/3) is not a magic number. It is the factor that enables compatible results of the emission lines and others definitions in the Bohr model.
The hypothesis A is the best in this new theory and it gave us these equations:
.
$c_{(f)} = c_{(0)}$ (1+Z)^(-1/3) or $c_{(f)} = c_{(0)}$ [(t+ $K_{(A)}$)/ $K_{(A)}$] ^(-1/2)
.
t=$K_{(A)}$ [(1+Z)^(2/3)-1] (Gyr)
.
D= 2$K_{(A)}$ [(1+Z)^(1/3)-1] or D= 2$K_{(A)}$ { [(t+$K_{(A)}$) / $K_{(A)}$]^(1/2) } (Gly)
.
$r_{(f)} = r_{(0)}$(1+Z)^(2/3) or $r_{(f)} = r_{(0)}$(t+$K_{(A)}$)/$K_{(A)}$
.
$c_{(f)}$: Light speed in a past frame
.

$c_{(0)}$: Light speed at local frame
.
t: time (Gyr)
.
$K_{(A)}$: Contant = 20.657 582 148 185 686 (h^{-1}).
$h \equiv H_0$=71 km/s/mpc, already within the value.
.
D: distance (Gly)
.
$r_{(f)}$: Bohr radius or size of objects in the past (m).
.
$r_{(0)}$: Bohr radius or size of objects at present (m).
.
In this theory, the shrinking speed in one meter is about 4.84 nm/C (nanometers per century), at present.
Light speed, in this theory should grow 7.25 mm/s per year, at present.

.

1.2) Constant dependence

To simplify, we could call $(1+Z)^{-1/3}=K_C$, so, $c_{(f)}=K_C\, c_{(o)}$.
Z : (observed redshift).
$c_{(f)}$: Light speed in the observed frame.
$c_{(o)}$: Light speed in our local frame.
We must apply the constant K_c for all formulae and constants used in physics were light speed "c" is used.
So that simplify the work, we can apply the constant K_C directly over the used values of our local frame, observing the right exponential use of light speed, as follow:

$c_f = K_C\, c_O$	"light speed"
$\lambda_f = \lambda_0 (K_c)^{-3}$	"wavelength emission lines"
$r_f = (K_C)^{-2}\, r_o$	"Bohr radius and body sizes"
$E_f = E_0 (K_c)^4$	"energy of the emission lines"
$\sigma_{W(f)} = \sigma_{W(0)} (K_C)$	"Wien Displacement Constant"
$R_{\infty(f)} = R_{\infty(0)} (K_C)^3$	"Rydberg constant"
$T_{(f)} = T_{(0)} (K_C)^4$	"Temperature of emission lines (Wien)"
$k_{e(f)} = k_{e(0)} (K_C)^2$	"Coulomb constant"

$_{(f)}$ Observed frame in the past.
$_{(0)}$ our local frame at present

2) Example changing to a reference frame in the past

Suppose we search a galaxy and we detect Lyα emissions being three times greater than Lyα in our world. The observed wavelength is exactly 3647,01 Å.
The H Lyα in our frame is 1215,67 Å.
So, the redshift Z is $Ly\alpha_{(f)} / Ly\alpha_{(o)} - 1 = 2$
The constant K_C is $(1+Z)^{-1/3} = (1+2)^{-1/3}$ = 0.693361274
So, K_C = 0.693361274
Now we can determine the main constants of the reference frame in the past;

SMT-VLS simplified formulae for Z = 2

Symbol	formula*	local frame$_{(0)}$	past frame$_{(f)}$	units
$c_{(f)}$	$c_{(0)}\ (K_c)$	299 792 458	207 864 480.72	m/s
$Ly\alpha_{(f)}$	$Ly\alpha_{(0)}\ (Kc)^{-3}$	1215.67	3647.01	Å
$r_{(f)}$ (Bohr)	$r_{(0)}\ (Kc)^{-2}$	0.529	1.000 4	Å
$E_{(f)}$	$E_{(0)}\ (K_c)^{4}$	10.204	2.358	eV
$\sigma_{w(f)}$	$\sigma_{w(0)}\ (K_c)$	0.002 897 8	0.002 009 22	mK
$R_{\infty\,(f)}$	$R_{\infty(0)}\ (Kc)^{2}$	10 973 730.68	3 657 910.23	m^{-1}
$T_{(f)}$ (Lyα)	$T_{(o)}\ (K_c)^{4}$	23 836	5 509	K
$k_{e(f)}$	$k_{e(0)}\ (Kc)^{2}$	8 987 551 792.30	4 320 764 237.85	$kg\ m^{3}\ s^{-2}\ C^{-2}$

$_{(f)}$ observed frame in the past

$_{(0)}$ local frame at present $\qquad K_c = (1+Z)^{-1/3} = 0.693\ 361$

* simplified formula

In the Hubble law, if we consider H_0 = 71 km/s/mpc and assume it is enough to determine the distance, we have:

$$D = \frac{[(1+Z)^2 - 1]\ c}{[(1+Z)^2 + 1]\ \ H_0\ (10)^3} \quad mpc \qquad [4]$$

1 mpc = 3.261 563 777 167 430 Mly
c = light speed = 299 792 458 m/s
Distance = 3380,3 mpc = 11,02 Gly
Time (past) = 11,02 Gyr
H_0 : Hubble constant

3) The CMBs in the SMTwVSL

The lack of peak emissions pattern, avoids us to determine exactly what actually the CMBs are. This could let us to various scenarios.

3.1) One is assuming the CMBs could be the first thermal emission lines. In this scenario, if we consider the CMBs are Lyman alpha emissions, we have:

$$Z = \frac{1.063214\ (10)^{-3}}{1.21567\ (10)^{-7}} - 1 \quad \Rightarrow$$

Z: ______________________8744.91

K_c: ___________________________0.048536114 c = _____________________14 550 761 m/s

Temperature: ______________0.13 K

Wavelength: ______________1.063214 mm

Energy: __________________5.663 $(10)^{-5}$ eV

$\sigma_{W(c)}$ ____________________0.000140648 mK

3.2) another scenario is to assume that CMBs could be hyperfine transitions of neutral hydrogen, known as 21 cm line. In this case, the redshift is negative (blue shift), and the radiation could be the remaining of the collapsed universe, which provided the energy to the emergence of the universe we know. In this case, we have:

$$Z = \frac{1.063214\ (10)^{-3}}{2.1106114\ (10)^{-1}} - 1 \quad \Rightarrow$$

Z (blue shift):_____________-0.99496253

Temperature:______________15.9 K

Wavelength: ______________1.063214 mm

Energy: __________________6.8 $(10)^{-3}$ eV

$\sigma_{W(f)}$_____________________0.0169043 mK

Light speed “c”_______________1 748 839 285.4 m/s

The SMTwVSL states that light speed “c” varies along the time, so the energy of the photon also varies with the time. In this scenario, there is a systematic error in our researches assuming that the observed waves, emitted in the past and detected in our devices have the same energy as the waves produced in our local frame. We shouldn’t forget that the waves with the same frequency and phase, can be added and give the impression that they are more energetic. The amount of energy of each wave could be determined by the receptor, but it may not represent the real emitted energy of the wave.

The peak of CMBs are the most populous microwaves in the universe, as well hydrogen is the most abundant element in nature, so, for now we should suppose (and state), CMBs are hyperfine transitions of neutral hydrogen, that provided part of the energy needed for the emergence of the universe we know. I know it is a hard exercise for minds which are indoctrinated in assuming the BB as a fact, but I hope you can. We know the CMBs are the most distant emissions detected, among the unresolved CXRBs, so, in this scenario, the wavelength of the CMB, compared with the be hyperfine transition of neutral hydrogen in our reference frame (21 cm), result negative redshift (blue shift). This could only be attributed to the remaining hyperfine transition of neutral hydrogen, in its collapsed last phase of the cyclic universe.

In this scenario, as issued later, the redshift is negative (blue shift), and can be calculated as follow:

$$Z = \frac{1.063214\ (10)^{-3}}{2.1106114\ (10)^{-1}} - 1 \quad \Rightarrow$$

Z = -0.99496253

$K_c = (1+Z)^{-1/3} = (1 - 0.99496253)^{-1/3} \Rightarrow$

$K_c = 5.833499939$

In this scenario, we have;

The Light speed $C_{(f)}$ is 1 748 839 285.42 m/s

r_f = 1.555 pm (Bohr radius)

$Ly\alpha_{(f)}$ = 6.123975 Å

E (Lyα(f)) =11816 eV

E (n=1) = 15749 eV

T ($Ly\alpha_{(f)}$)= 27602611 K

$\sigma_{W(f)}$ =0.016904316 mK

In this transition, ($Ly\alpha_{(f)}$), the hyperfine transitions of neutral hydrogen can happen in the ground state and would be:

Temperature:________________15.9 K

Wavelength:________________1.063214 mm

Energy:____________________6.803 $(10)^{-3}$ eV

$\sigma_{W(f)}$ ____________________0.016904316 mK

The unexpected and most important result in this scenario is that the Lyα(f) falls surprisingly in the lower end band of the unresolved CXRB (Cosmic X-Ray Background). So, the SMTwVSL, in this scenario, could solve the origin of the CMB and the unresolved CXRB as being remnants of the past collapsed cycle of the universe, and the future of this cycle. Of course, this needs further resources, but it is a strong evidence of the consistence of this theory.

4) The Fine-Structure Constant in the SMTwVSL

The fine-structure constant "α" is a dimensionless value, but it reflects the relationship between the electromagnetic coupling constant 'e" and "$\mathcal{E}_o$", "h", and "c".

$e = (2\ \alpha\ \mathcal{E}_o\ h\ C)^{1/2}$ or $e^2 = 2\ \alpha\ \mathcal{E}_o\ h\ C$

As c is variable, result $\mathcal{E}_o$ is also variable, then α should vary at the same rate of c.

Rewriting the expression we have:

$$\alpha = \frac{e^2}{2h\varepsilon_0 c}$$

But,

$$\varepsilon_0 = \frac{1}{\mu_0 c^2}$$

And,

$\mu_0 = 4\ \pi\ (10)^{-7} = constant$

So,

$$\alpha = \frac{e^2 \mu_0 c}{2h}$$

Or,

$$\alpha = \frac{e^2\ 2\pi\ (10)^{-7} c}{h} \Rightarrow$$

.

$$\alpha_0 = \frac{e^2\, 2\pi\, (10)^{-7} c_0}{h} \Rightarrow$$

.

$$\alpha_{(f)} = \frac{e^2\, 2\pi\, (10)^{-7} c_{(f)}}{h} \Rightarrow$$

.

$$\alpha_{(f)} = \frac{e^2\, 2\pi\, (10)^{-7} c_{(0)} K_c}{h} \Rightarrow$$

.

$\alpha_{(f)} = \alpha_{(o)}\, (K_c)$

Or,

$\alpha_{(f)} = \alpha_{(o)}\, (1+Z)^{-1/3}$

$\alpha_{(o)} = 0.007\ 297\ 352\ 5698(24)$

$_{(o)}$:our local frame
$_{(f)}$: distant reference frame
Z : redshift
K_C: scaling factor of light speed "c" as a function of Z

"However, if multiple coupling constants are allowed to vary simultaneously, not just *α*, then in fact almost all combinations of values support a form of stellar fusion."[3]

"Specifically, the values of α, G, and/or c can change by more than two orders of magnitude in any direction (and by larger factors in some directions) and still allow for stars to function."[6]

5) The redshift, the time and distance relationship

Since in the SMTwVSL there is not receding speed, there is no reason to determine the distance and time, (past), based in the standard model (expanding universe), which is necessary determine the apparent receding speed to infer the distance and past time, based in the Hubble constant.
In SMTwVSL, size of the atom decreases along the time, so, time should be defined by the rule of Lost in VoLume per unit of time (LVL). The LVL can be mathematically defined as d_{VL}/dt.. The LVL should vary along the time, according to the size of the atoms, and this variance could be proportional to the surface or to the volume of the atoms along the time.
This would let us to two hypotheses, A, and B.
The hypothesis A proposes the LVL variance could be proportional to the surface of the atoms.
The hypothesis B proposes the LVL variance could be proportional to the volume of the atoms.
Now we can develop the two hypotheses to analyze the possibility of choose the one which best fit to the observations.

5.1) Hypothesis A:

5.1.1 Determination of time and distance relationship in function of (1+Z)

5.1.1.1) Determination of time (hypoth. A)

The hypothesis A proposes that LVL (d_{VL}/dt) varies proportionally to the surface S_f of the atom.
The LVL is defined as the vary of the volume "d_{VL}" by the vary of time "d_t" ie LVL = d_{VL}/d_t , so, we can write:

$$\frac{LVL}{S_f} = constant = K_S \Rightarrow \frac{d_{VL}/d_t}{S_f} = K_S \Rightarrow$$

.

$\frac{d_{VL}}{d_t\, S_f} = K_S \Rightarrow$

.

$$d_t = \frac{d_{(VL)}}{K_{(S)}\ S_{(f)}} \qquad (II)$$

The volume of the atom *VL* can be defined by the function:

.

$VL = \frac{4\,\pi\, r_f^3}{3}$

.

$r_f = r_o\,(1+Z)^{2/3}$

Let $(1+Z) = x \Rightarrow$

$r_f = r_0\, x^{2/3} \Rightarrow$

.

$VL = \frac{4\,\pi\,\left(r_0\, x^{2/3}\right)^3}{3} \Rightarrow$

.

$$VL = \frac{4\,\pi\, r_{(0)}^3\, x^2}{3} \Rightarrow$$

.

$$d_{VL} = \frac{8\,\pi\, r_{(0)}^3\, x}{3}$$

.

$S_f = 4\,\pi\ r_f^{\,2} \Rightarrow S_f = 4\,\pi\ (r_o\,(1+Z)^{2/3})^2 \Rightarrow$

$S_f = 4\,\pi\ r_o^{\,2}\,(1+Z)^{4/3} \Rightarrow$

Replacing (1+*Z*) by *x*, we have:

.

$$S_f = 4\,\pi\ r_o^{\,2}\ x^{4/3}$$

.

Applying $S_{(f)}$ and d_{VL} in (II), we have:

.

$$d_t = \frac{8\,\pi\, r_0^3\, x}{3\, K_S}\ \frac{1}{4\,\pi\, r_0^2\ x^{4/3}} \Rightarrow$$

.

$d_t = \frac{2\, r_0}{3\, K_S}\ x^{-1/3} \Rightarrow$

.

$\int d_t = \int \frac{2\, r_0}{3\, K_S}\ x^{-1/3}\ d_x + C \Rightarrow$

.

$t = \frac{2 r_0\ 3\, x^{2/3}}{3\, K_S\ 2} + C \Rightarrow$

.

$$t = \frac{1}{K_S} r_0\, x^{2/3} + C$$

.

But, $r_o\ x^{2/3} = r_f$, so, time is directly proportional to the radius of the atoms. This case is similar to a spherical block of ice, defrosting in an isothermal medium. The release of liquid water decreases along the time, because it is proportional to the surface of the block, but the decreasing in the diameter is constant per unit of time.

But, (r_o/K_S) is constant and we can replace it by K_A, so,

$$t = K_A\ x^{2/3} + C$$

For $Z = 0 \Rightarrow x=1$ and $t = 0$

So, for $Z = 0$ we have:

$$0 = K_A\ (1)^{2/3} + C \Rightarrow$$

$$C = -K_A \Rightarrow$$

$$t = K_A\ x^{2/3} - K_A \Rightarrow$$

$$t = K_A\,(x^{2/3} - 1) \qquad \text{(III)} \quad \text{(Gyr)}$$

$$x = (1+Z) \Rightarrow$$

$$t = K_A\,[(1+Z)^{2/3} - 1] \qquad \text{(IV)} \quad \text{(Gyr)}$$

t = Time (Gyr)

K_A = Stretching factor of the function so that fitting it to the measured observations at low redshifts.

5.1.1.2) Distance of deep space objects (hypoth. A)

In the SMTwVSL, light speed was smaller in the past, but has been getting bigger along the time due the dynamic evolution of free space. In reality, when matter shrinks it is absorbing energy from free space.

In this scenario, there is not anymore equivalence between distance, (Gly), and time, (Gyr). Time is bigger than distance because of the smaller light speed in the past, although in the local frame, (at low redshifts), this difference is neglected.

In a very small time period "dt" in a past frame, (f), the distance "d_D" traveled by light would be:

$$d_D = c_{(f)}\, d_t \quad \text{(V)}$$

$c_{(f)} = c_{(o)}\,(1+Z)^{-1/3}$

Let $(1+Z) = x \Rightarrow$

$$c_{(f)} = c_{(o)}\, x^{-1/3} \quad \text{(VI)}$$

$$t = K_A(x^{2/3} - 1) \quad \text{(III)} \Rightarrow$$

.

$$d_t = t' = \frac{t}{d_x} = \frac{2\, K_A\, x^{-1/3}}{3} \qquad (VII)$$

.
Appling (VII), and (VI) in (V) we have:
.

$$d_D = c_0\, x^{-1/3} \frac{2\, K_A\, x^{-1/3}}{3} d_x \Rightarrow$$

.

$$d_D = c_0 \frac{2\, K_A\, x^{-2/3}}{3} d_x \Rightarrow$$

.

$$\int d_D = \int c_0 \frac{2\, K_A x^{-2/3}}{3} d_x \Rightarrow$$

.

.

$$D = c_o\, 2\, K_A\, x^{1/3} + C$$

$x=(1+Z)$

For Z = 0 => x=1 and D=0, so,

$$0 = c_o\, 2\, K_A\, x^{1/3} + C \Rightarrow$$

$$C = -\, c_o\, 2\, K_A \Rightarrow$$

$$D = c_o\, 2\, K_A\, (x^{1/3} - 1)$$

In this equation, light speed,"c_o", in the local frame, must be in Gly/Gyr =1, then:

$$D = 2\, K_A\, (x^{1/3} - 1)$$

(x=1+Z) =>

$$D = 2\, K_A\, [(1+Z)^{1/3} - 1] \quad \text{(VIII)} \quad \text{(Gly)}$$

In this scenario, the distance at Z=14 is 60.58 (h^{-1}) Gly, although past time is 104.99 (h^{-1}) Gyr. $h \equiv H_0$=71 km/s/mpc, already within the value.

5.1.2) The redshift *Z* can now be expressed in function of the time *t* as follow:
.

$$t = KA\, (x2/3 - 1) \quad \text{(V)} \quad \Rightarrow$$

.

$$\frac{t}{K_A} = x^{2/3} - 1 \Rightarrow x^{2/3} = \frac{t}{K_A} + 1 \Rightarrow x = \left[\frac{t + K_A}{K_A}\right]^{3/2} \Rightarrow$$

.

$$x = (1+Z) \quad \Rightarrow$$

.

$$Z = \left[\frac{t + K_A}{K_A}\right]^{3/2} - 1 \quad \text{(IX)}$$

t : (Gyr)

5.1.3) Now we can determine the relationship of the evolution of light speed "c_f " in function of any time, for hypothesis_A.

$c_{(f)} = c_{(o)} (1+Z)^{-1/3}$ (I)

Applying (IX) in the (I) we have:

$$c_{(f)} = c_{(0)} \left\{1 + \left[\frac{t+K_A}{K_A}\right]^{3/2} - 1\right\}^{-1/3} \Rightarrow$$

.

$$c_{(f)} = c_{(0)} \left\{\left[\frac{t+K_A}{K_A}\right]^{3/2}\right\}^{-1/3} \Rightarrow$$

.

$$c_{(f)} = c_{(0)} \left[\frac{t+K_A}{K_A}\right]^{-1/2} \qquad (X)$$

.

5.1.4) Now we can determine the relationship of the evolution of the size of objects "rf" in function of any time, for hypothesis A.

.

$$Z = \left[\frac{t+K_A}{K_A}\right]^{3/2} - 1 \qquad (IX)$$

.

$r_{(f)} = r_{(o)} (K_c)^{-2}$

$K_c = (1+Z)^{-1/3} \Rightarrow$

$r_{(f)} = r_{(o)} [(1+Z)^{-1/3}]^{-2} \Rightarrow$

$r_{(f)} = r_{(o)} (1+Z)^{2/3}$

Applying (IX) in the above function we have:

.

$$r_{(f)} = r_{(0)} \left\{1 + \left[\frac{t+K_A}{K_A}\right]^{3/2} - 1\right\}^{2/3} \Rightarrow$$

.

$$r_{(f)} = r_{(0)} \left[\frac{t+K_A}{K_A}\right]$$

5.1.5) Now we can determine the relationship of the evolution of the distances "D" in function of any time, for hypothesis A.

$$D = 2\,K_A\,[(1+Z)^{1/3}-1] \quad (VIII) \quad (Gly)$$

But,

$$Z = \left[\frac{t+K_A}{K_A}\right]^{3/2} - 1 \qquad (IX)$$

Then,

$$D = 2K_{(A)} \left\{1 + \left[\frac{t+K_A}{K_A}\right]^{3/2} - 1\right\}^{1/3} - 1 \Rightarrow$$

.

$$D = 2K_{(A)}\left\{\left[\frac{t+K_A}{K_A}\right]^{1/2} - 1\right\} \qquad (Gly)$$

5.1.6) The K_A constant

The farthest bodies newly observed present redshift of about *Z* =13.2, so we will limit our researches in the range of *Z* from 0 to 14, to be conservative (not so distant, but not sharply)
The distance *D* in the standard model for Z= 13.2 is 13.636 (h^{-1}) Gly,[4]

The Bohr radius in the SMTwVSL model, r_o and r_f are:

r_o = 5.291773 x 10^{-11} m (for Z=0)

r_f = 3.102 x 10^{-10} m (for Z=13,2)

r_o = Bohr radius of neutral hydrogen at present, in our local frame (o).

r_f = Bohr radius of neutral hydrogen in the past frame (f).

The above equations (V) and (IX), are basic to define all relationships in the SMTwVSL, for hypothesis A.
Now we can determine the best value for the constant K_A, so that calibrating the equation to observed distances. This calibration must be done at low redshift, where we can determine distances by parallax. This mean the above function should give us the same value when the redshift is null (zero), and at low redshifts give us neglected differences when compared within the standard model. This mean the tangent of the above function (IX), at *Z*= 0, should be the same as the tangent in the correspondent function of the standard model (expanding universe).

In the standard model, (expanding universe), the equation to define the distance can be expressed as follow:
.

$$D = \frac{[(1+Z)^2 - 1]\ c}{[(1+Z)^2 + 1]\ \ H_0\,(10)^3} \quad mpc \quad [4]$$

.
c = light speed = 299792458 m/s
H_0 = Hubble constant = 71 km/s/mpc

To take the result in Gly and Gyr, the equation becomes:
.

$$D = (t) = \frac{[(1+Z)^2 - 1]\ c\ 3.26}{[(1+Z)^2 + 1]\ \ H_0\,(10)^6} \quad Gly\ (Gyr)$$

.
As “c” varies with time in the SMTwVSL, we must consider just the distance relationship of this equation, although at low Z, the difference between time and distance would be neglected.
.
We can replace *(1+Z)* by *X*, then,
.

$$D = \frac{(x^2 - 1)\ c\ 3.26}{(x^2 + 1)\ H_0\,(10)^6} \quad Gly \quad (XI)$$

.
x=(1+Z)
and:

.

$$(x^2-1)=u\,,\ \ (x^2+1)=v \quad and \quad d\left(\frac{u}{v}\right)=\frac{u'v-uv'}{v^2} \quad \Rightarrow$$

.

$$d_D=D'=\frac{D}{d_x}=\frac{2x^3+2\,x-2x^3+2x}{x^4+2x^2+1}\ \frac{c\,3.26}{H_0 10^6} \quad \Rightarrow$$

.

$$d_D=D'=\frac{D}{d_x}=\frac{4\,x}{x^4+2x^2+1}\ \frac{c\,3.26}{H_0 10^6} \quad (XII)$$

.

The function to determine distance "D" in the past time in the SMTwVSL model, hypothesis A, is:

D = 2 KA [$(1+Z)^{1/3}$ -1] (VIII).

We can replace *(1+Z)* by *X*, then,

D = 2 KA (x 1/3 – 1) ⇒

.

$$d_D=D'=\frac{D}{d_x}=\frac{1}{3}\ 2K_A\ \ x^{-2\,/3} \quad \Rightarrow$$

.

$$d_D=\frac{2K_A\,x^{-2/3}}{3} \quad (XIII)$$

.

x = (1+Z)

For Z = 0, ⇒ *x* = 1

To impose the same tangency of the two functions (VIII and XVI) at *x* = 1, implies (XV) = (XVI), at *x*=1, so, matching (XV) and (XVI), we have:

.

$$\frac{2\,K_A\,x^{-2/3}}{3}=\frac{4\,x}{x^4+2x^2+1}\ \frac{c\,3.26}{H_0 10^6} \quad \Rightarrow$$

.

$$\frac{2\,K_A}{3}=\frac{4}{1+2+1}\ \frac{c\,3.26}{H_0 10^6} \quad \Rightarrow$$

.

$$K_A=\frac{3\,c\,3.26^*}{2\,H_0(10)^6} \quad (XIV)$$

.

K_A = 20.657 582 148 185 686 (h^{-1}) (best value for K_A, for hypothesis A, for H_o = 71)

h≡H_0=71 km/s/mpc, already within the value.

* The reliable value of this conversion factor is 3.261 563 777 167 43

c = light speed = 299792458 m/s.

5.1.7) Shrinking speed *SHV* along the time in function of the redshift

The shrinking speed *SHV* of the Bohr radius can be defined as *dr/dt*.

The Bohr radius in the past is defined by the function:

.

$$r_f = r_0\, x^{2/3} \Rightarrow\ d_r = \frac{2r_0\, x^{-1/3}}{3}$$

.

$$t = K_A\, (x^{2/3} - 1)\ \text{(III)} \Rightarrow$$

.

$$d_t = \frac{2K_A x^{-1/3}}{3} d_x$$

.

$$SHV = \frac{d_r}{d_t} = \frac{2r_0\ \ x^{-1/3}}{3}\ \frac{3}{2K_A\ x^{-1/3}} \Rightarrow$$

.

$$\mathrm{SHV} = \frac{\mathrm{r_0}}{\mathrm{K_A}}\quad \mathrm{m/Gyr} \Rightarrow$$

.

$$\mathrm{SHV} = \frac{\mathrm{r_0}}{\mathrm{K_A}\ 31\ 557\ 600\ (10)^9}\quad (\mathrm{m/s})\quad (\mathrm{XV})$$

SHV = 8.117335 $(10)^{-29}$ (h) m/s = constant (for hypothesis A)

h≡H_0=71 km/s/mpc, already within the value.

The Shrinking speed is constant along the time.
This speed refers to Bohr radius.

5.1.8) Specific shrinking speed (SPV)

The specific shrinking speed is defined as $V_f\, /\, r_f$.
Vf : Shrinking speed in a reference frame SHV (XV).
r_f: Bohr radius in a reference frame. $r_f = r_o x^{2/3}$
So,

.

$$\mathrm{SPV} = \frac{\mathrm{r_0}}{\mathrm{K_A}\ 31\ 557\ 600\ (10)^9}\ \frac{1}{r_0\, x^{2/3}} \Rightarrow$$

.

$$\mathrm{SPV} = \frac{x^{-2/3}}{\mathrm{K_A}\ 31\ 557\ 600\ (10)^9}$$

$x = 1 + Z \Rightarrow$

.

$$\mathrm{SPV} = \frac{(1+\mathrm{Z})^{-2/3}}{\mathrm{K_A}\ 31\ 557\ 600\ (10)^9}\quad m/s\,/\mathrm{m}\quad (\mathrm{XVI})$$

.

.

$$SPV = \frac{(1+Z)^{-2/3}(3.086)\ (10)^{22}}{K_A(31\ 557\ 600)(10)^9\ (10)^3}\quad km/s\ /\ mpc \Rightarrow$$

.

$$SPV = \frac{(1+Z)^{-2/3}\ (3.086)(10)^{10}}{K_A(31\ 557\ 600)} \qquad km/s/\ mpc \quad \Rightarrow$$

.

For $Z = 0 \Rightarrow X = 1 \Rightarrow SPV = 1.534\ (10)^{-18}$ (h) m/s /m or 47,333 (h) km/s /mpc.
$h \equiv H_0$=71 km/s/mpc, already within the value.

This specific shrinking speed is 4.84 nm/C/m (nanometers per century per meter).

The equatorial radius of the Earth is 6 378 136.3 m.
The shrinking speed of the Earth radius would be:

SHV = (6378136.3) (1.534) $(10)^{-18}$ $\Rightarrow$

SHV = 9.7839 $(10)^{-12}$ m/s

1 year = 31 557 600 seconds, so,

SHV = (31 557 600) (9.7839)$(10)^{-12}$ m/year $\Rightarrow$
SHV = 3.0875 $(10)^{-4}$ m / yr
SHV = 0.30875 mm / yr
SHV = 308.75 m / Myr

5.2) Hypothesis B:

5.2.1 Determination of time and distance relationship in function of (1+Z)

5.2.1.1) Determination of time (hypoth. B)

This hypothesis proposes the *LVL* (d_{VL}/dt) variance is proportional to the volume VL_f of the atom, so we can write:
.

$$\frac{LVL}{VL_f} = constant = K_V \ \Rightarrow \ \frac{d_{VL}/d_t}{VL_f} = K_V \Rightarrow$$

.

$$\frac{d_{VL}}{d_t\, VL_f} = K_V \Rightarrow$$

.

$$d_t = \frac{d_{(VL)}}{K_{(V)}\ \ VL_{(f)}} \qquad (XVII)$$

.

The volume of the atom, “VL”, can be defined by the function:
.

$$\mathrm{VL}_{(f)} = \frac{4\,\pi\, r_f^3}{3}$$

.

$r_f = r_o\,(1+Z)^{2/3}$
Let $(1+Z) = x \Rightarrow$

$r_f = r_0\, x^{2/3} \Rightarrow$

.

$$\mathrm{VL}_{(f)} = \frac{4\,\pi\,(r_0\, x^{2/3})^3}{3} \Rightarrow$$

.

$$\mathrm{VL}_{(f)} = \frac{4\,\pi\, r_{(0)}^3 x^2}{3} \Rightarrow$$

.

$$d_{VL} = \frac{8\,\pi\, r_{(0)}^3\, x}{3} \Rightarrow$$

.

Apliing d_{VL} and $VL_{(f)}$ in (XVII), we have:

.

$$d_t = \frac{d_{(VL)}}{K_{(V)}\; VL_{(f)}} \quad (XVII) \Rightarrow$$

.

$$d_t = \frac{8\,\pi\, r_0^3\, x}{3\, K_V} \; \frac{3}{4\,\pi\, r_0^3\; x^2} \Rightarrow$$

.

$$d_t = \frac{2}{K_V\, x} \Rightarrow$$

.

But, $(2/K_v)$ is constant, so we can call:

.

$$\frac{2}{K_V} = K_B \Rightarrow$$

.

$$d_t = K_B \frac{1}{x} \quad (XVIII) \Rightarrow$$

.

$$\int \boldsymbol{d_t} = \int \boldsymbol{K_B \frac{1}{x} d_x + C} \Rightarrow$$

.

$$t = K_B\, ln(x) + C$$

For Z = 0 ⇒ x=1 and $t = 0$

So, for Z=0, we have:

$$0 = K_B\, ln(1) + C \Rightarrow C = 0 \Rightarrow$$

$t = K_B \ln(x) \Rightarrow$

$x = (1+Z) \Rightarrow$

$$t = K_B\, ln(1+Z) \qquad \text{(XIX)}$$

.

$$x = (1+Z) \Rightarrow \frac{t}{K_B} = ln(1+Z) \Rightarrow (1+\mathrm{Z}) = e^{(t/K_B)} \Rightarrow$$

.

$$Z = e^{(t/K_B)} - 1 \quad (XX)$$

e = 2.718 281 828 459 05
t : (Gyr)
K_B = see chapter 5.2.2)

5.2.1.2) Distance of deep space objects (hypoth. B)

In the SMTwVSL, light speed was smaller in the past, but has been getting bigger along the time due the dynamic evolution of free space. In reality, when matter shrinks it is absorbing energy from free space.
In this scenario, there is not anymore equivalence between distance, (Gly), and time, (Gyr). Time is bigger than distance because of the smaller light speed in the past, although in the local frame, (at low redshift), this difference is neglected.

In a very small time period "dt" in the past frame "f", the space "d_D" traveled by light would be:

$$d_D = c_{(f)}\, dt \quad (V)$$

$c_{(f)} = c_{(o)} (1+Z)^{-1/3}$
Let (1+Z)= x ⇒

$$c_{(f)} = c_{(o)}\, x^{-1/3} \quad (VI)$$

.

$$t = K_B \ln(x) \quad (XIX) \Rightarrow$$

.

$$d_t = K_B \frac{1}{x} \quad (XVIII)$$

.
Appling (VI) and (XVIII) in (V) we have:
.

$$d_D = c_o\, x^{-1/3} K_B \frac{1}{x} \quad d_x \Rightarrow$$

.

$$d_D = c_o K_B\, x^{-4/3} \quad d_x \Rightarrow$$

$$d_D = c_0 K_B\, (x)^{-4/3} \; d_x \Rightarrow$$

.

$$\int d_D = \int c_0 K_B\; x^{-4/3} + C \;\; d_x \Rightarrow$$

.

$$D = -c_o\, 3\, K_B\; x^{-1/3} + C \Rightarrow$$

For Z = 0 => x=1 and D=0, so,

$$0 = -c_o\, 3\, K_B\, 1^{-1/3} + C \Rightarrow$$

$$C = c_o\, 3\, K_B$$

Then,

$$D = c_o\, 3\, K_B\, (1 - x^{-1/3})$$

In this equation, light speed,"c_o", in the local frame, must be in Gly/Gyr =1, then:

$$D = 3\, K_B\, (1 - x^{-1/3})$$

(x=1+Z) ⇒

$$D = 3\ K_B\ [1 - (1+Z)^{-1/3}] \quad (XXI) \quad \text{(Gly)}$$

In this scenario, the distance at Z=11.5 is 23.51 Gly, although past time is 34.78 Gyr.

5.2.2) The K_B constant

Now we can determine the best value to the constant K_B, so that calibrating the equation to observed distances. This calibration must be done at low redshift, where we can determine distances by parallax. This mean the above function should give us the same value when the redshift is null (zero), and at low redshifts give us neglected differences.
This mean the tangent of the above function,(XIII), at Z= 0, should be the same as the tangent in the respective function of the standard model (expanding universe).

In the standard model, (expanding universe), the equation to define the distance can be expressed as follow:

.

$$D = \frac{(x^2 - 1)\ c\ 3.26}{(x^2 + 1)\ H_0\ (10)^6} \quad Gly \quad (XI)$$

.

x = (1+Z)
and:

.

$$d_D = D' = \frac{D}{d_x} = \frac{4\ x}{x^4 + 2x^2 + 1}\ \frac{c\ 3.26}{H_0 10^6} \quad (XII)$$

x = (1+Z)

.

In the "SMTwVSL", hypothesis B, the equation that describes distance is:

$$D = 3\ K_B\ [1 - (1+Z)^{-1/3}] \quad (XXI) \quad \text{(Gly)}$$

Let (1+Z) = x ⇒

$$D = 3\ K_B\ (1 - x^{-1/3}) \quad \Rightarrow$$

$$d_D = K_B\ (x)^{-4/3} \quad (XXII)$$

.

For Z = 0, => x = 1
To force the same tangency in the two functions (XI) and (XXI) at x = 1, implies (XII) = (XXII), at x=1.
Then, matching (XII) and (XXII), we have:

.

$$K_B\ x^{-4/3} = \frac{4\ x}{x^4 + 2x^2 + 1}\ \frac{c\ 3.26}{H_0 10^6} \quad \Rightarrow$$

.

$$K_B = \frac{4\ x^{7/3}}{x^4 + 2x^2 + 1}\ \frac{c\ 3.26}{H_0 10^6} \quad \Rightarrow$$

.

$$K_B = \frac{4}{1+2+1} \frac{c\ 3.26}{H_0 10^6} \quad \Rightarrow$$
.

.

$$K_B = \frac{c\ 3.26^*}{H_0 10^6} \qquad \text{(XXIII)}$$

.

K_B = 13.771 721 432 124 (h^{-1}) (best value for K_B in the "SMTwVSL" hypothesis B, for H_o = 71)
h≡H_0=71 km/s/mpc, already within the value.
* The reliable value of this conversion factor is 3.261 563 777 167 43
c = light speed = 299792458 m/s

5.2.3) The Shrinking speed *SHV* along the time in function of the redshift

The shrinking speed *SHV* of the Bohr radius can be defined as dr/dt.

The Bohr radius in the past is defined by the function:
.

$$r_f = r_0\, x^{2/3} \;\Rightarrow\; d_r = \frac{2\, r_0\, x^{-1/3}}{3}$$

.

$x = (1+Z)$
.

$$d_t = K_B \frac{1}{x} \quad \text{(XVIII)}$$
.

$$SHV = \frac{d_r}{d_t} = \frac{2\, r_0\, x^{-1/3}}{3} \frac{x}{K_B} \Rightarrow$$
.

$$SHV = \frac{d_r}{d_t} = \frac{2\, r_0\, x^{2/3}}{3 K_B} \quad (m/Gyr) \Rightarrow$$
.

$$SHV = \frac{d_r}{d_t} = \frac{2\, r_0\, x^{2/3}}{3K_B\ (31\,557\,600)(10)^9} \quad (m/s)\ \text{(XXIV)}$$

.
This speed refers to Bohr radius and every matter body.
For Z=0, x=1 and SHV = 8.1173 $(10)^{-29}$ m/s (Bohr radius)

5.2.4) Specific shrinking speed *SPV*

The specific shrinking speed *SPV* is defined as V_f / r_f.
V_f : Shrinking speed in a reference frame *SHV* (XXIV).
r_f: Bohr radius in a reference frame.

$$r_f = r_o\, x^{2/3} \;\Rightarrow$$

.

$$SPV = \frac{V_f}{f} = \frac{2\, r_0\, x^{2/3}}{3K_B\,(31\,557\,600)\,(10)^9}\,\frac{1}{r_0\, x^{2/3}} \quad \Rightarrow$$

.

$$SPV = \frac{V_f}{f} = \frac{2}{3K_B\,(31\,557\,600)\,(10)^9} \quad (m/s\,/m) \quad \text{(XXV)} \quad \Rightarrow$$

.

SPV = 1.534 $(10)^{-18}$ (h) m/s /m

h≡H_0=71 km/s/mpc, already within the value.

.

$$SPV = \frac{2\,(3.086)\,(10)^{22}}{3\,K_B(31\,557\,600)\,10^9\,10^3} \quad km/s\,/mpc \quad \Rightarrow$$

.

$$SPV = \frac{2\,(3.086)\,(10)^{10}}{3\,K_B(31\,557\,600)} \quad km/s\,/mpc \quad \Rightarrow$$

.

SPV constant = 1.534 $(10)^{-18}$ (h) m/s /m or 47,333 (h) km/s /mpc, (for hypothesis B)

h≡H_0=71 km/s/mpc, already within the value.

5.2.5) The Shrinking acceleration (SHA) along the time in function of the redshift

The shrinking acceleration *SHA* is defined as the variation of the speed in function of the time, so, it can be defined mathematically as:

.

$$SHA = \frac{d_V}{d_t}$$

.

V = SHV (XXIV) and d_t = (XVIII)

.

$$SHV = \frac{2\, r_0\, x^{2/3}}{3K_B\,(31\,557\,600)(10)^9} \quad (m/s)\ \text{(XXIV)} \quad \Rightarrow$$

.

$$d_V = SHV' = \frac{(2)(2)\, r_0\, x^{-1/3}}{(3)(3)K_B\,(31\,557\,600)(10)^9} \quad \Rightarrow$$

.

$$d_V = SHV' = \frac{4\, r_0\, x^{-1/3}}{9K_B\,(31\,557\,600)(10)^9}$$

.

$$d_t = K_B\,\frac{1}{x} \quad (XVIII) \quad \Rightarrow$$

.

$$SHA = \frac{d_V}{d_t} = \frac{4\, r_0\, x^{-1/3}}{9K_B\,(31\,557\,600)(10)^9}\,\frac{x}{K_B} \Rightarrow$$

.

$$SHA = \frac{4\, r_0\; x^{2/3}}{9\,(K_B)^2\;(31\,557\,600)\,(10)^9} \quad (m/s/Gyr)\ (XXVI) \Rightarrow$$

.
$x = (1+Z)$

For Z=0, x=1 and SHA = 3.9295 $(10)^{-30}$ (h^2) m/s /Gyr
$h \equiv H_0$=71 km/s/mpc, already within the value.

Or 3.9295 $(10)^{-33}$ m/s /Myr

This acceleration refers to Bohr radius.
For Z=0, x=1 and SHA = 1.24517 $(10)^{-46}$ m/s^2

5.2.6) Specific shrinking acceleration (SPA) along the time in function of the redshift

The specific acceleration *SPA* is defined as the shrinking acceleration *SHA* per unit of length.
This means as bigger the length of a body, as bigger the *SHA*.

The *SPA* can be defined as:
.
$$SPA = \frac{SHA}{r_f}$$
.
$$SHA : (XXVI), and, r_f = r_o \, x^{2/3}$$

.
$$SHA = \frac{4\, r_0 \;\; x^{2/3}}{9\,(K_B)^2 \;\; (31\,557\,600)\,(10)^9} \;\; (m/s/Gyr)\;(XXVI) \Rightarrow$$
.
$$SPA = \frac{4\, r_0 \;\; x^{2/3}}{9\,(K_B)^2 \;\; (31\,557\,600)\,(10)^9} \; \frac{1}{r_0 \, x^{2/3}} \quad \Rightarrow$$
.
$$SPA = \frac{4}{9\,(K_B)^2 \;\; (31\,557\,600)\,(10)^9} \;\; (m/s\,/\,m/Gyr) \Rightarrow$$
.
$$SPA = \frac{4}{9\,(K_B)^2 \;\; (31\,557\,600)\,(10)^{12}} \;\; (m/s\,/\,m/Myr) \;\; \text{(XXVII)}$$

For hypothesis B, *SPA* = Constant = 7.4257 $(10)^{-23}$ m/s /m /Myr

For hypothesis B, *SPA* = Constant = 2.2913 $(10)^{-3}$ km/s /mpc /Myr

5.3) The Graphic 01 presents the comparative evolution of distance (Gly) and time (Gyr), in function of redshift “Z”, for the ACDM_SN1A distance ladder, the SMTwVSL hypothesis A, the SMTwVSL hypothesis B, and the Hubble law, were:

5.3.1) For “ACDM SN1A dist. Lader”:

$$D = 10^{(\mu/5 + 1)} \qquad (pc)$$

μ[2]: Betoule et al 2014, Table F1, page 30, “http://arxiv.org/pdf/1401.4064v2.pdf “.

1 pc = 3.261 563 777 167 430 $(10)^{-9}$ Gly

5.3.2) For ΛCDM linear function (theoretical):

D = t = 13.771 721 432 124 (Z) (h^{-1}) (Gly) and (Gyr)

h≡H_0=71 km/s/mpc, already within the value.
The slope of this function is exactly the tangent of the functions (IV), (VIII, (XIX), (XXI), and (XI), for Z=0

5.3.3) For “SMTwVSL” hypothesis A:

$$t = K_A\,[(1+Z)^{2/3} - 1] \quad \text{(Gyr)} \quad \text{(IV)}$$

$$D = 2K_A\,[(1+Z)^{1/3} - 1] \quad \text{(Gly)} \quad \text{(XIII)}$$

K_A = 20.657 582 148 185 686 (h^{-1}) (best value for K_A, for hypothesis A, for H_o = 71)
h≡H_0=71 km/s/mpc, already within the value.

Z = Redshift

5..3.4) For “SMTwVSL” hypothesis B:

$$t = K_B\,\ln(1+Z) \quad \text{(Gyr)} \quad \text{(XIX)}$$

$$D = 3K_B\,[1-(1+Z)^{-1/3}] \quad \text{(Gly)} \quad \text{(XXI)}$$

K_B = 13.771 721 432 124 (h^{-1})
h≡H_0=71 km/s/mpc, already within the value.

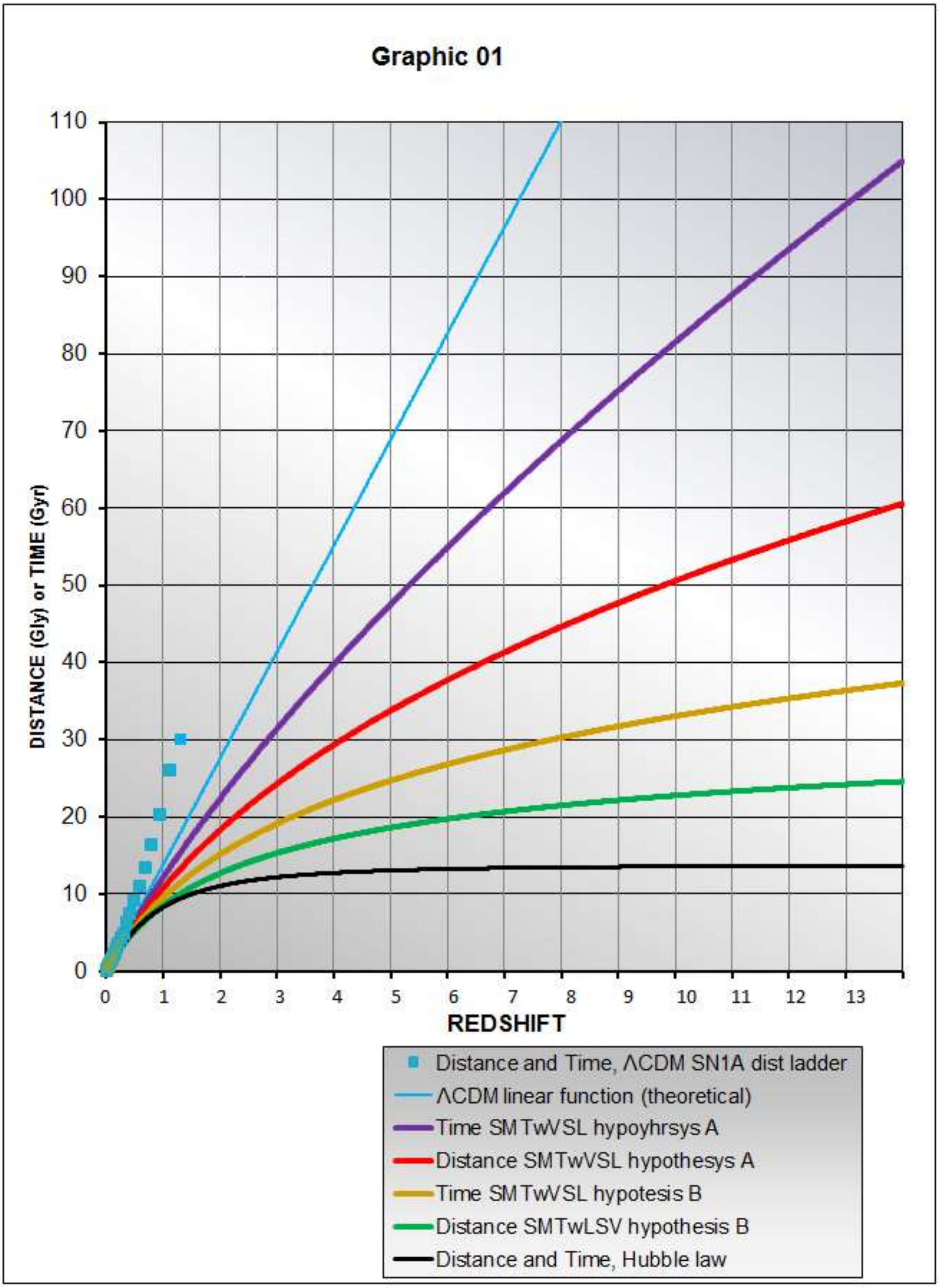
Z = Redshift

5.3.5) For “Hubble_law”:
.

$$D = \frac{(x^2-1)\, c\, 3.26^*}{(x^2+1)\, H_0\, (10)^6} \quad Gly \quad (XI)$$

x=(1+Z)
* The reliable value of this conversion factor is 3.261 563 777 167 43
Ho= Hubble constant = 71 km/s /mpc
Z = Redshift
c = light speed = 299 792 458 m/s

5.3.6) Graphic 01



6) The distance ladder

6.1) The SN1A distance ladder and the SMTwVSL

The SMTwVSL is characterized by the possibility of vary the light speed along the time as the factor of the redshift of the emissions in the past.
This justifies the bigger size of the atoms and bodies in the past, as well the longer wavelength emissions, the smaller energy and smaller temperature.
The main relationship relative to the proprieties of the matter and the redshift is listed below.

$c_f = c_o (1+Z)^{-1/3}$ *Light speed*

$\lambda_f = \lambda_o (1+Z)$ *Wavelength emissions*

$r_f = r_o (1+Z)^{2/3}$ *Bohr radius, energetic n level radius and body sizes*

$E_f = E_o (1+Z)^{-4/3}$ *Energy of emission lines*

$\sigma_f = \sigma_o (1+Z)^{-1/3}$ *Wien Displacement Constant.*

$R_{\infty f} = R_{\infty 0} (1+Z)^{-1}$ *Rydberg constant*

$T_f = T_o (1+Z)^{-4/3}$ *Temperature of emission lines*

The SN1A distance ladder is a system used to calculate distances based in the hypothesis which their luminosity peaks are constant, so, as fainter the flux received in our telescopes, as longer the distance from the Earth. The relationship for distance and flux is:

$$\frac{F_1}{F_2} = \frac{(D_2)^2}{(D_1)^2} \quad (XXVIII)$$

Where F_1 and D_1 are flux and distance of a near and known SN1A, which distance can be determined by parallax, used as standard reference.
F_2 is the measured flux of a more distant SN1A, and D_2 is the unknown distance to be calculated.

The "distance modulus" "μ" is a logarithm scale where:

$$\mu = 2.5 \, log \left(\frac{F_1}{F_2}\right)$$

This equation works well for low redshifts, but in the SMTwVSL the flux F_2 is affected by the redshift. In the past, the energy of the emissions was smaller, as well the flux F_2.
The energy of the emissions in the past is defined by the function $E_f = E_o (1+Z)^{-4/3}$.
To nullify the effects of the redshift in the observed flux F_2, we should replace it by corrected flux F_{2c}.
The F_{2c} should be higher, as if the emissions were emitted in our local frame, at present.
F_{2c} can be defined as follow;

$$F_{2c} = F_2 \frac{E_0}{E_f} \Rightarrow$$

$$F_{2c} = F_2 \frac{E_0}{E_0(1+Z)^{-4/3}} \Rightarrow$$

$$\boldsymbol{F_{2c} = F_2 (1+Z)^{4/3}} \quad \text{(XXXI)}$$

Then, the relationship between fluxes and distances becomes:

.
$$\frac{F_1}{F_{2c}} = \frac{(D_2)^2}{(D_1)^2} \Rightarrow$$
.
$$\frac{F_1}{F_2(1+Z)^{4/3}} = \frac{(D_2)^2}{(D_1)^2} \Rightarrow$$

.
$$\frac{F_1}{F_2} = \frac{(1+Z)^{4/3}\,(D_2)^2}{(D_1)^2} \quad \text{(XXXII)} \Rightarrow$$
.
The distance modulus function for the “SMTwVSL” becomes:
.
$$\mu = 2.5\ log\left(\frac{F_1}{F_2}\right) \Rightarrow$$
.
$$\mu = 2.5 log\left[\frac{(1+Z)^{4/3}\,(D_2)^2}{(D_1)^2}\right] \Rightarrow$$

.

$$\mu = 2.5 log\left[\frac{(1+Z)^{4/3}\,D_2}{D_1}\right]^2 \Rightarrow$$
.
$$\mu = 5 log\,\frac{(1+Z)^{2/3}\,D_2}{D_1} \Rightarrow$$
.
$$\boldsymbol{\mu} = 5\ \log\,(D_2) + 5\ \log\,(1+Z)^{2/3} - 5\ \log\,(D_1) \Rightarrow$$
D1 = 10 pc $\Rightarrow$ log D1 = 1 $\Rightarrow$

$$\boldsymbol{\mu} = 5\ \log D_2 + [(10/3)\ \log(1+Z)] - 5 \quad \text{(XXXIII)}$$

Or :

$$\boldsymbol{\mu} = 5\ [\log D_2 + (2/3)\ \log(1+Z) - 1] \quad \text{(XXXIV)}$$

D_2 : (pc)
.
$$\frac{\mu}{5} = log(D_2) + (2/3)\,log(1+Z) - 1 \Rightarrow$$
.
.
$$log(D_2) = \frac{\mu}{5} - (2/3)\,log(1+Z) + 1 \Rightarrow$$
.
$$D_2 = 10^{[\mu/5 - (2/3)\log(1+Z) + 1]} \ \text{(pc)} \quad \text{(XXXV)}$$

.
6.2) Graphic 02 presents the comparative evolution of the distance modulus μ.

6.2.1) The observed evolution of the distance modulus μ is represented by square blue points, which were extracted from Betoule et al 2014, Table F1, page 30[2] “http://arxiv.org/pdf/1401.4064v2.pdf “.

6.2.2) Evolution of the expected μ to the ΛCDM linear function for distance is represented by a blue curve.

$D = t = 13.771\ 721\ 432\ 124\ (Z)\ (h^{-1})$ (Gly) and (Gyr)

$h \equiv H_0$=71 km/s/mpc, already within the value.

The slope of the linear function of "D" is the tangent of the functions (IV), (VIII, (XIX), (XXI), and (XI), for Z=0

$$\mu = 5 \log(D) - 5 \quad \text{(XXIX)}$$

6.2.3) Evolution of the expected μ to the SMTwVSL, hypothesis A is in red color.
It is defined by the equation:

$$\mu = 5 \log D + [(10/3) \log(1+Z)] - 5 \qquad \text{(XXXIII)}$$

.D: pc

$$D = 2\ K_A\ [(1+Z)^{1/3}\ -1] \quad \text{(VIII) (Gly)}$$

$1\ pc = 3.26156377716743\ (10)^{-9}$ Gly

$K_{(A)}$: Contant = 20.657 582 148 185 686 (h^{-1})

$h \equiv H_0$=71 km/s/mpc, already within the value.

Z = Redshift

6.2.4) Evolution of the expected μ to the SMTwVSL, hypothesis B is in green color.
It is defined by the equation:

$$\mu = 5 \log D + [(10/3) \log(1+Z)] - 5 \quad \text{(XXXIII)}$$

(D_2 : pc)

Where: $$D = 3\ K_B\ [1- (1+Z)^{-1/3}] \quad \text{(XXI) (Gly)}$$

.1 pc = $3.26156377715743\ (10)^{-9}$ Gly

$K_B = 13.771\ 721\ 432\ 124\ (h^{-1})$

$h \equiv H_0$=71 km/s/mpc, already within the value.

Z = Redshift

6.2.5) Evolution of the expected μ to the Standard Model (Hubble law) is in black color.
It is defined by the equation:

$$\mu = 5 \log(D) - 5 \quad \text{(XXIX)}$$

.

(D : pc)

Where:

$$D = \frac{(x^2 - 1)\ c\ 3.26^*}{(x^2 + 1)\ H_0\ (10)^6} \quad Gly \quad (XI)$$

.

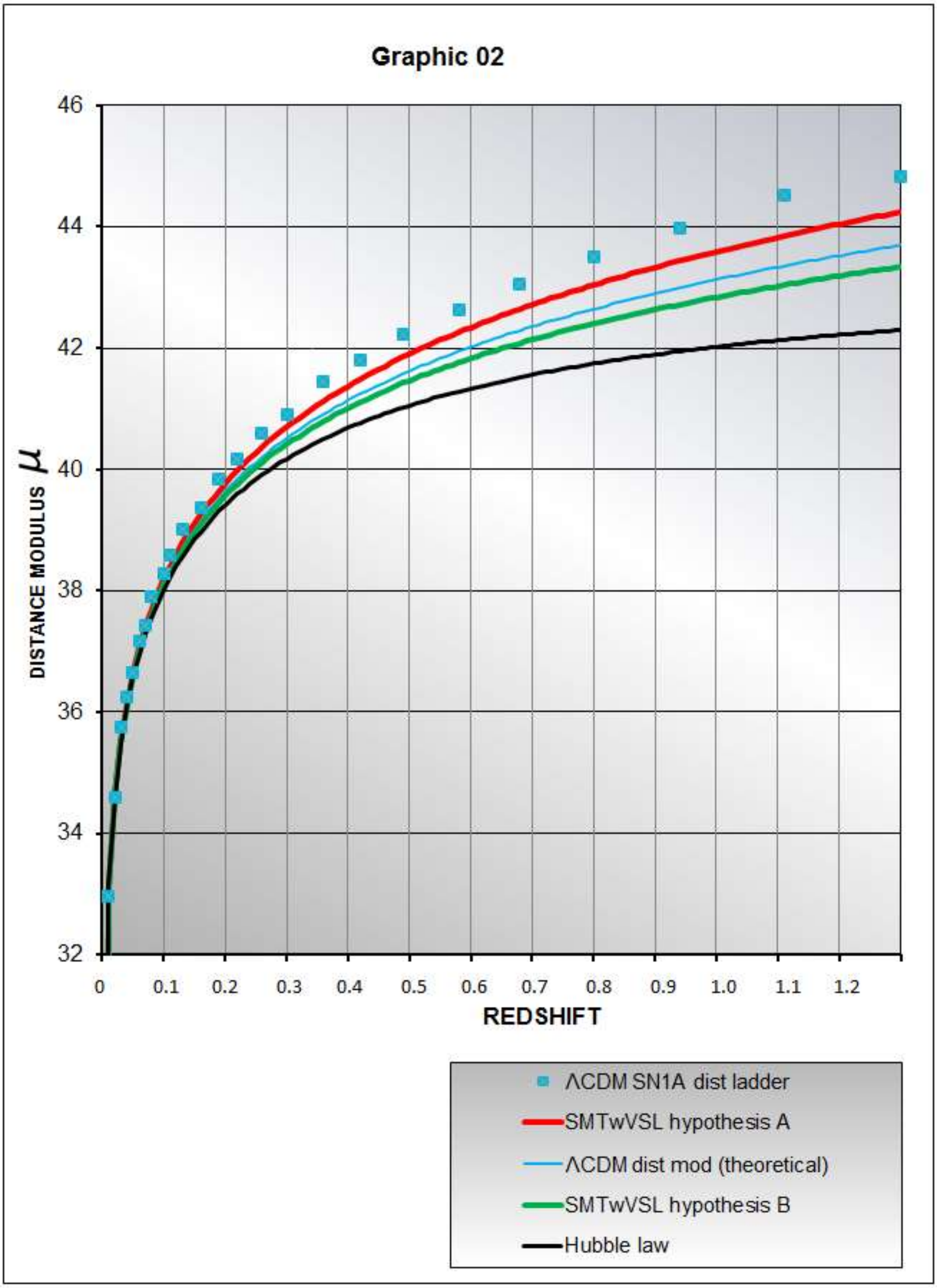
x=(1+Z)

* The reliable value of this conversion factor is 3.261 563 777 167 43

Ho= Hubble constant = 71 km/s /mpc

Z = Redshift

6.2.6) Graphic 02:



.

The best curve that fits the observational data is the "SMTwVSL Hypothesis A".

No need for dark energy.

Although, both hypothesis A and B could be possible, since distance modulus is unnecessary to define distances in SMTwVSL.

7) Predictions in the SMTwVSL

7.1) The Effects of the shrinking matter in the local frame

The expanding universe theory considers that the local frame is not affected by the expansion due the gravitational bond of the bodies. This statement is contradictory because the limit of the gravitational bond is very difficult to define, maybe there is not such limit.
In the SMTwVSL, the shrinking effect happens everywhere, so the orbit of the Earth and the planets should present an apparent growing along the time.
The distance between the Earth and the Sun is very difficult to determine accurately. The apparent expansion should be about 7.26 m/year. For one this could be a great variation, for others small. The true is that we cannot use a stick to measure it. The fact is that such distance varies every time, since the orbit is elliptical, but the eccentricity of the orbit also varies due tide effect of the planets of the solar system. Here we have a great challenge to measuring this distance with enough accuracy to detect this variance.
The only way to measure it precisely should be launching two space telescopes, positioned in the L4 and L5 Sun-Earth LaGrange points. If we measure precisely the distances between these two points whole the year, we could determine accurately the average distance, and compare the variation year by year. This is not an easy job, because in theory, we need a new parameter to measure distances and time, based on constant frequencies and wavelengths in the Universe, such as the peaks of CMBs and (or) unresolved CXRBs.

7.2) Remaining emissions from the last collapsed universe

In the third chapter, we have two possible scenarios concerning to the origin of the CMBs.
If we adopt the second scenario (3.2), we can make an interesting prediction.
When we can get more accurate measurements of CXRBs, probably, we can distinguish two peaks at the end of the lower energetic band. These peaks should be 2025.67 eV and 2400.80 eV detected in our devices, corresponding to Lyα and Lyβ emissions respectively.

When corrected by the appropriated light speed of the reference frame, the energies and the wavelength of these emissions should be:

Lyα: $E = 11817$ eV $\lambda = 6.1206$ Å

Lyβ $E = 14005$ eV $\lambda = 5.1643$ Å

8) SMTwVSL solutions

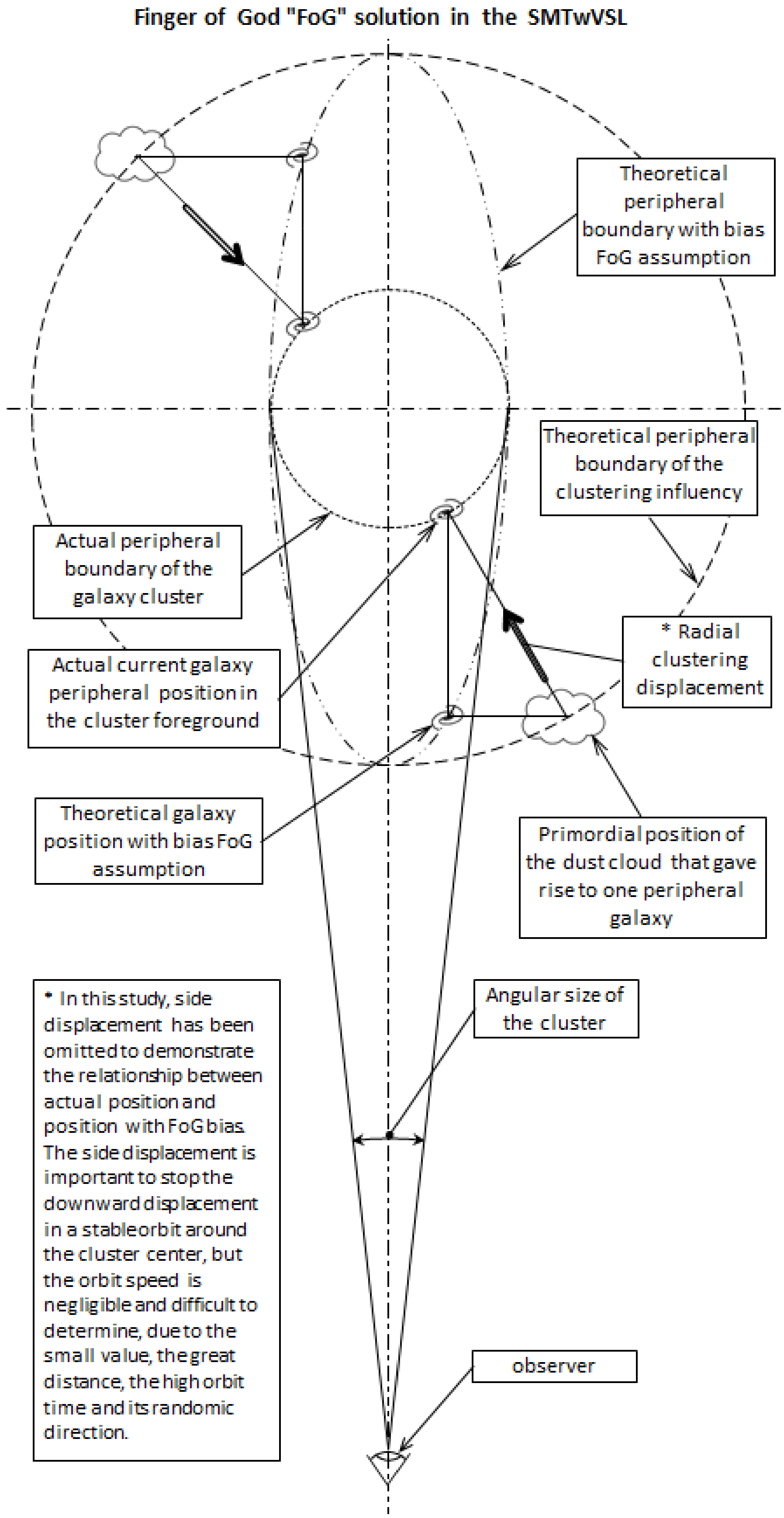
8.1) Faint blue galaxies problem

In the SMTwVSL as cyclic universe, we propose the faint blue galaxies are not dwarfs, but normal galaxies in the last universe cycle. Their distances are very bigger than thought. That is why we watch them in small angular sizes and great surface brightness.
If we leave the Andromeda galaxy in the redshift of 0.5 in the last universe cycle, hypothesis A, its angular size would be 0.45 arc seconds and the distance would be 100.8 Gly. This angular size is compatible with measured sizes [5].
This approach would be confirmed in the near future, by analyzing of the pattern distribution of them in the mirroring images, in the strong lensing clusters.
The mirroring images are important to detect whether pattern distribution of faint blue galaxies and normal galaxies differ, when viewed from different angles, whose parallax confirmation would be evidence they are not in the foreground, but in the background.
The parallax provided by mirroring images can provide evidence of the extreme difference in distances between FBGs and normal galaxies with similar redshift, observed in the foreground lensing cluster. The work of the James Web Space Telescope, (JWST), will be providential to solve this issue.

8.2) Finger of God "FoG"

The Finger of God (FoG) is an elongation observed in distant structures, along the line of sight (LoS), when redshift is associated with receding velocities in the FoG bias. It is as if the gathering property of clusters only happened on axes

orthogonal to the LoS, which is unjustifiable and incoherent, since the supposed expansion of the universe should not happen in the cluster foreground, due its gravitational field.
When seen through the SMTwVSL bias, the FoG effect does not exist. Below, we have the schematic behavior of the cluster with details of both biases and their consequences. There is a radial displacement clustering within a large sphere that contains the supposed FoG.



In this scenario, we live in a peripheral bubble of clusters centered in the Shapley Super Cluster (SSC).
The theoretical peripheral boundary of the observed clustering of SSC influence is about 200(h^{-1}) Mly in diameter, which corresponds to the length of the supposed FoG bias. The actual size of SSC is about 31.5 (h^{-1})Mly in its bigger angular size of 2.8°. In our simulation, the radial displacement of the peripheral galaxies is 84.25(h^{-1}) Mly. It last 105(h^{-1}) Gyr and resulted in a radial speed of about 1011 km/s. The mass required inside this boundary influence is $6.81(10)^{14}$ $M_{\odot}$.

The distance from MW to SSC is 197.47(h^{-1})Mpc (644 Mly). This is the radius of our Local Bubble of Galaxy Clusters (LBGC). To account for the inferred velocity of the Local Group of about 600 km/s[18], the mass of LBGC should be about 6.15 $(10)^{16}$ $M_{\odot}$. This speed is accumulated for about 105(h^{-1}) Gyr of gravitational free fall towards SSC. The displacement of Local Group in this journey is about 100(h^{-1}) Mly in our simulation.

9) Gravity and energy relationship

9.1) Issue of the origin of gravity goes through the philosophical approach to the anthropological nature of this property of matter, since the universe would not exist, at least as we know it, if gravity did not exist. Without gravity, we would at best be a gaseous mass evenly distributed in the universe.
That said, we can conclude that gravity is a property of matter. Considering the equivalence between matter and energy, we might say that gravity is in fact the property of energy to concentrate, since other forms of energy, such as light, dark matter and black holes, are affected by gravity, but, in theory, are not considered matter.

9.2) Antimatter

Antimatter behavior is not yet a consensus in the scientific community, especially if it attracts or repels normal matter. If matter and antimatter repels, there would be antimatter superclusters bubbles equally spread in the universe, as well there are bubbles of matter superclusters. The structure of these bubbles should be cubic. In this structure, there are three orthogonal axes in each bubble. Taking a bubble as a reference, the neighbors on each axis, (6), must be the inverse of the central one, i.e. our neighbors bubbles should be of antimatter superclusters.

“Given that most of the mass of antinuclei comes from the strong force that binds quarks together, physicists think it unlikely that antimatter experiences an opposite gravitational force to matter. Nevertheless, precise measurements of the free fall of antiatoms could reveal subtle differences that would open an important crack in our current understanding.”[7]
https://home.cern/news/news/experiments/aegis-track-test-free-fall-antimatter

“Given that most of the mass of antinuclei comes from massless gluons that bind their constituent quarks, physicists think it unlikely that antimatter experiences an opposite gravitational force to matter and therefore “falls up”. Nevertheless, precise measurements of the free fall of antiatoms could reveal subtle differences that would open an important crack in current understanding.”[8]
https://cerncourier.com/a/aegis-on-track-to-test-freefall-of-antimatter/

At the beginning of each cycle of the universe, matter and antimatter do not annihilate each other due to scattering and their repellent behavior, at least at that time. On the other hand, matter attracts matter and antimatter attracts antimatter. In this scenario, small anisotropies initiate the progressive concentration of matter and antimatter that resulted in what exists in the universe today, and that predicts the existence of antimatter super clusters somewhere. Behavior of the universe is characterized by symmetry, so it is a “sine qua non” question to admit this behavior.
The total energy of the universe should be null, if we assume that energy of antimatter is negative, but in the real world, energy can be negative just relative to a defined frame, likewise negative and positive electric charge produce positive energy in every possible combinations, ++,+-, or --. However, we can assume signals + or – to energy, according to its flux. When the energy flux increases the energy of the reference body, or the reference frame, this energy is positive, otherwise it is negative.
In this scenario, we can conclude that positive energy attracts positive energy, negative energy attracts negative energy, and positive energy repels negative energy.

9.3) Free space energy

Free space energy or vacuum energy is one of the biggest mysteries in humanity's current time.
In 2014, NASA published studies indicating that the density of the universe would be 9.9×10^{-27} kg/m^3. [9] Of this density, the breakdown would be:
Ordinary matter: 4.6 % = 4.55×10^{-28} kg/m^3
Cold dark matter: 24 % = 2.38×10^{-27} kg/m^3
Dark energy: 24 % = 7.07×10^{-27} kg/m^3
https://wmap.gsfc.nasa.gov/universe/uni_matter.html

Dark energy is not part of our study because it is a crutch to keep up the theory of the expanding universe and the big bang going, so we must keep only the values of the ordinary matter and the dark matter.

Then the total density of the universe would be about 2.83 x 10^{-27} kg/m^3, and ordinary matter 4.55 x 10^{-28} kg/m^3, equivalent to about 16%, and the cold dark matter 2.38 x 10^{-27} kg/m^3, equivalent to about 84%.

Free space energy density is not constant. Energy tends to come together, but there are restrictions for that to happen. To come together energy must become matter (or antimatter), because matter gives volume to the atom, that prevents two atoms from occupying the same space.
Energy of matter and antimatter does not come from nothing, it comes from free space, so, free space is full of energy. Once matter is created, the condition is created for its gathering to occur, even if this matter is later transformed into pure energy, as in black holes and dark matter.
The more matter created, the lower the energy of free space, and the faster the speed of light.
When the speed of light increases, the energy of matter increases, due the shrinking behavior of the electron shells of the atoms, and the raise of the Coulomb constant.
The vibrational energy of the electron shells are exactly equivalent to the potential energy of the electron in that distance, but with a positive value. This energy also comes from free space. It is noteworthy that the Coulomb constant "k_e" also increases with the increasing speed of light.

ke is exactly $c^2(10)^{-7}$ kg m^3 s^{-2} C^{-2}

The shell radius of hydrogen in the ground state is exactly twice the Bohr radius.

9.4) Dark matter

Dark Matter is just the variation of the energy of free space, or vacuum.
It is called dark "matter", because we believe that gravitational attraction is an exclusive property of matter, but in fact, it is a property of energy, for example, light, black hole and kinetic energy are types of energy subject to the action of gravity. The adjective "dark" occurs due to the lack of knowledge of its origin.
The systematic error is to think that free space has constant energy density everywhere every time. In reality, we are confused by the fact that we can only measure energy density differences between one region and another, but we have not, until now, been able to measure the total energy density of free space in a region.
Dark matter plays the role of the energy density of free space. The destructive interference of electromagnetic waves contributes to raise the energy of free space. This rise in energy is locally, but spread and vanishes soon due the dynamical movement of everything. We only notice the difference from one region to the other of free space energy, which we call "dark matter".
This behavior can be easily verified in the experiment carried out by "Louis Rancourt & Philip J. Tattersall"[17] in which the weight of a body is affected by a box of mirrors that reflect light in a zig zag pattern. The weight progressively increases in the direction of the box, as a function of time, indicating an accumulation of energy, which is progressively dissipated when lights are turned off.

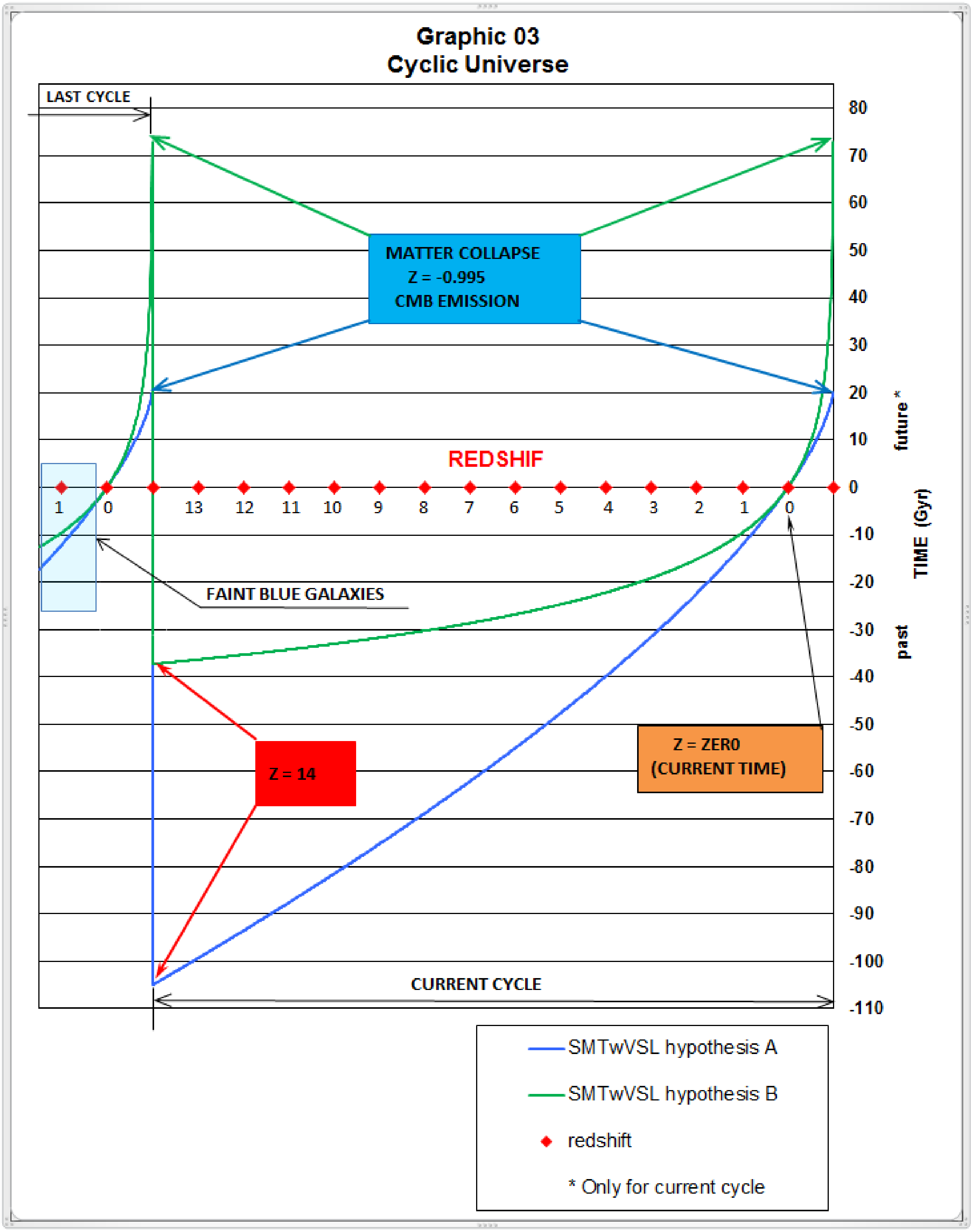
10) Conclusions

The cyclic universe would be the best solution to the present cosmologic blunders.
If we adopt the hypothesis A, the total cycle of each phase happens between Z~=14 to Z= -0.99496253

In this scenario, the beginning of the current cycle took place 105 billion years ago and there are still 20 billion years left to the end.
The total time of each cycle of the universe would be 125 Gyr.

The graphic 03 presents the evolution of time in function of redshift in a cyclic universe, table 02 presents a miscellaneous of formulae derived in the SMT-LSV, and table 03, a comparison between the Big Bang Theory and the Shrinking Matter Theory with Variation of the Speed of Light (SMTwVSL).

Graphic 03:



Graphic 03
Cyclic Universe
LAST CYCLE
MATTER COLLAPSE
Z = -0.995
CMB EMISSION
REDSHIF
1
0
13
12
11
10
9
8
7
6
5
4
3
2
1
0
FAINT BLUE GALAXIES
Z = 14
Z = ZERO
(CURRENT TIME)
CURRENT CYCLE
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
future *
TIME (Gyr)
past
SMTwVSL hypothesis A
SMTwVSL hypothesis B
redshift
* Only for current cycle

Table 02:

Formulae table for Shrinking Matter Theory with Variable Speed of Light (SMTwVSL)

Symbol	Basic equation	SMTwVSL formulae: Variation in functio of Z	SMTwVSL formulae: Variation in function of t	Variation rate per year at present	
c (m/s)	$c=\frac{1}{\sqrt{\varepsilon_0\mu_0}}$ [11]	$c_{(f)}=c_{(0)}(1+Z)^{-1/3}$	$c_{(f)}=c_{(0)}\left[\frac{t+K_A}{K_A}\right]^{-1/2}$	past	-2,420 419 420 445 80E-11
				future	2,420 419 420 445 80E-11
Z	$Z=\frac{\lambda_{obsv}-\lambda_{emit}}{\lambda_{emit}}$ [15]	--	$Z=\left[\frac{t+K_A}{K_A}\right]^{3/2}-1$	past	7,261 258 261 337 39E-11
				future	-7,261 258 261 337 39E-11
t (Gyr)	--------------------------------	$t_{(f)}=K_{(A)}[(1+Z)^{2/3}-1]$	--------------------------------	-----	------------------
				-----	------------------
D (Gly)	--------------------------------	$D_{(f)}=2K_{(A)}[(1+Z)^{1/3}-1]$	$D_{(f)}=2K_{(A)}\left\{\left[\frac{t+K_A}{K_A}\right]^{1/2}-1\right\}$	-----	------------------
				-----	------------------
r (m)	$r_n=\frac{n^2\hbar^2}{Zk_e e^2 m_e}$ [10]	$r_{(f)}=r_{(0)}(1+Z)^{2/3}$	$r_{(f)}=r_{(0)}\left[\frac{t+K_A}{K_A}\right]$	past	4,840 838 840 891 59E-11
				future	-4,840 838 840 891 59E-11
λ (m)	c /ν [10]	$\lambda_{(f)}=\lambda_{(0)}(1+Z)$	$\lambda_{(f)}=\lambda_{(0)}\left[\frac{t+K_A}{K_A}\right]^{3/2}$	past	7,261 258 261 337 39E-11
				future	-7,261 258 261 337 39E-11
ν (Hz)	c /λ [10]	$\nu_{(f)}=\nu_{(0)}(1+Z)^{-4/3}$	$\nu_{(f)}=\nu_{(0)}\left[\frac{t+K_A}{K_A}\right]^{-2}$	past	-9,681 677 681 783 19E-11
				future	9,681 677 681 783 19E-11
ε_0	$\varepsilon_0=\frac{1}{\mu_0 c^2}$ [11]	$\varepsilon_{(f)}=\varepsilon_{(0)}(1+Z)^{2/3}$	$\varepsilon_{(f)}=\varepsilon_{(0)}\frac{t+K_A}{K_A}$	past	4,840 838 840 891 59E-11
				future	-4,840 838 840 891 59E-11
α	$\alpha=\frac{e^2}{2h\varepsilon_0 c}$ [12]	$\alpha_{(f)}=\alpha_{(0)}(1+Z)^{-1/3}$	$\alpha_{(f)}=\alpha_{(0)}\left[\frac{t+K_A}{K_A}\right]^{-1/2}$	past	-2,420 419 420 445 80E-11
				future	2,420 419 420 445 80E-11
k_e	$k_e=\frac{1}{4\pi\varepsilon_0}$ [13]	$k_{e(f)}=k_{e(0)}(1+Z)^{-2/3}$	$k_{e(f)}=k_{e(0)}\left[\frac{t+K_A}{K_A}\right]^{-1}$	past	-4,840 838 840 891 59E-11
				future	4,840 838 840 891 59E-11
E	$E=-\frac{Z^2(k_e e^2)^2 m_e}{2\hbar^2 n^2}$ [10]	$E_{(f)}=E_{(0)}(1+Z)^{-4/3}$	$E_{(f)}=E_{(0)}\left[\frac{t+K_A}{K_A}\right]^{-2}$	past	-9,681 677 681 783 19E-11
				future	9,681 677 681 783 19E-11
σ_w	$\sigma_w=\frac{hc}{xk}$ [14]	$\sigma_{W(f)}=\sigma_{W(0)}(1+Z)^{-1/3}$	$\sigma_{w(f)}=\sigma_{w(0)}\left[\frac{t+K_A}{K_A}\right]^{-1/2}$	past	-2,420 419 420 445 80E-11
				future	2,420 419 420 445 80E-11
T	$T=\frac{\sigma_w}{\lambda}$ [14]	$T_{(f)}=T_{(0)}(1+Z)^{-4/3}$	$T_{(f)}=T_{(0)}\left[\frac{t+K_A}{K_A}\right]^{-2}$	past	-9,681 677 681 783 19E-11
				future	9,681 677 681 783 19E-11
R_∞	$\frac{1}{\lambda}=R_\infty\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right)$ [10]	$R_{\infty(f)}=R_{\infty(0)}(1+Z)^{-1}$	$R_{\infty(f)}=R_{\infty(0)}\left[\frac{t+K_A}{K_A}\right]^{-3/2}$	past	-7,261 258 261 337 39E-11
				future	7,261 258 261 337 39E-11
r_s	$r_s=\frac{2GM}{c^2}$ [16]	$r_{s(f)}=r_{s(0)}(1+Z)^{2/3}$	$r_{s(f)}=r_{s(0)}\left[\frac{t+K_A}{K_A}\right]$	past	4,840 838 840 891 59E-11
				future	-4,840 838 840 891 59E-11

10) Bohr_model
11) Vacuum_permittivity
12) Fine-structure_constant
13) Coulomb_constant
14) Wien displacement constant
15) Redshift
16) Black_hole

$c_{(0)}$ =	299 792 458	m/s
$K_{(A)}$= (h^{-1}) 20.657 582 148 185 686		
h ≡ H0 = 71 km/s/mpc, already within the value		
t: (Gyr) (for future, time "t" must be negative in the formulae)		

Table 03:

Big Bang theory (BBT) x Shrinking Matter Theory with Variable Speed of Light (SMTwVSL)

PHENOMENON	BBT		SMTwVLS	
Redshift	defined:	Dopller shift	defined:	Longer emissions in the past
Time	undefined: dual solutions	Huble law and (or) SN1A distance ladder	defined:	Simple equation
Distance	undefined: dual solutions	Huble law and (or) SN1A distance ladder	defined:	Simple equation
Dark Energy	undefined		defined:	Not necessary
Dark Matter	undefined		defined:	Variation of the energy of free space
peak of the CMBs origin	undefined		defined:	Hydrogen hyper fine transition in the collapse of matter
Finger of God "FoG"	undefined		defined:	There was radial displacement of Galaxies in a large sphere that contains the supposed FoG
Excess of Faint Blue Galaxies (FBGs)	undefined		defined:	normal galaxies in the previous cycle of the universe
Peak of the unresolved CXRBs origin	undefined		prediction:	Lyα and Lyβ emissions in the collapsing phase of the the previous cycle of the universe

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12- https://en.wikipedia.org/wiki/Fine-structure_constant

13- https://en.wikipedia.org/wiki/Coulomb_constant

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