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MCS Physics

Article 3:

Hubble Expansion

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Abstract

Based on Richard Feynman's argument in rejection of Fatio/Le-Sage's gravity, I indicate that dark energy, or the "something" that pushes galaxies apart must do its magic without killing inertia of the galactic matter rotational motion. I then turn to investigate the Hubble expansion: independent studies from different areas of physics reveal that the age of the universe is closely 13.7Gy. This substantially corresponds to the inverse of the Hubble parameter H_0. I suggest that our era is not unique: the age of the universe **at any given time** ATB is equal to the inverse of the Hubble parameter at the given time. I propose to substitute the conventional Hubble parameter H_0 which relates to expansion of distances, by a volumetric form of the same, $\boldsymbol{vH_0}$, corresponding to the **volumetric** expansion of space. A formula is derived accordingly, which connects between the volumetric Hubble parameter at any given age of the universe, the volumetric Hubble parameter at any other given age, and the time separation between these two ages. Logical study of the formula reveals that the Hubble expansion is analogous to, and may actually result from, an addition of constant amount of space "units" per a unit of time, into the universe. I postulate that space itself possesses the peculiar property of interacting with matter in a selective manner which on the one hand results with a drag thereby producing the universal expansion, and on the other complies with Feynman's argument and does not result with an inertia killing drag. In the initiation of the bang, the first constant amount entered a zero volume gravity free universe, since gravity depends on the presence of space, and was able to occur only after a time delay T_2 (see Article 2) each *EMP* must experience before it builds up its field and before it can respond to fields generated by others. In the absence of gravity, no energy nor inflaton were required for initiating the bang and for dragging the elementary particles apart merely by space units entering in between. I further postulate that as a phenomenon of space, gravity is distributed volumetrically. Consequently, for cosmological distances the propagation of gravity becomes slower than the expansion of space, thus receding galaxies are gravitationally unbounded. It follows that the Hubble expansion does not require any sort of energy, since there is no gravitational attraction to defeat, nor inertia to produce.

Dark Energy and Richard Feynman's Argument

In order to explain the expansion of the universe according to Hubble's law physicist have postulated the existence of a mysterious anti-gravity energy commonly termed "dark energy" which fills the universe and tends to push galaxies apart.

If indeed such energy exists, it must interact with galactic matter and "tell" it where to move, otherwise, i.e. if matter goes unnoticed by, it would not be affected and galaxies would not be pushed apart.

Professors of physics very commonly simulate to their audience the Hubble's law and the distance dependent velocity between receding galaxies by comparing galaxies to pennies glued to the surface of an inflating ball (analogous to a 2D space), or by comparing them to black specks dragged apart in the dough of a poppy seeds muffin rising during its baking (analogous to a 3D space). Such simulations indeed assume an interaction between the poppy seeds and the dough or between the surface of the ball and the pennies. The dough does not allow free motion of seeds, the coins are glued to the ball surface, and moreover the expanding surface is not permeable to coins. Galaxies, however, are not coins. They contain matter orbiting in inertial rotational motion, i.e. matter which space (including its energetic constituents if any) is completely permeable to it.

The simulations are therefore good for imagining the law but explain nothing concerning how galactic matter can be selective: "fixed" to the inflating space while at the same time "unfixed" to it so as to allow its rotational motion last for billions of years without losing inertia (or vice versa, how "dark energy" can be selective in its interactions with galactic matter). In his series of lectures titled "The Character of Physical Law"[1], Richard Feynman used similar argument to conclude "so, that is the end of that theory" referring to the Fatio/Le-Sage's theory of gravitation. The question according to Feynman is not only how gravity (and in our case some sort of anti-gravity) can be explained, but also whether the explanation is consistent with other motions exemplified by the gravitating matter.

Explaining the expansion of the universe by postulating a "dark energy" without complying with Feynman's argument, has the same scientific value as explaining conventional gravity by postulating a "magic energy", i.e. no scientific value.

In the remaining of this article and in articles to follow I am taking the challenge of explaining how galaxies can be pushed apart by "something" interacting with their matter and yet allowing it to keep moving without losing inertia. As a first step towards this goal, let explore the Hubble's law.

Is there anything constant involved with the Hubble parameter?

Variations in the Hubble parameter are conventionally associated by physicists with the dominance of gravity at early eras which gave way to the dominance of dark energy at later eras, according to FLRW metrics. In the former section I doubted dark energy in view of Feynman's argument. I doubt it further, based on the following.

It is a fact that the age of the oldest stars inferable from spectral lines of radioactive elements[2] substantially agrees with the age of the universe, A_0, as inferred from other independent studies, and all approximately correspond to Hubble time, namely to the inverse of the Hubble parameter H_0:

$$A_0 = \frac{1}{H_0} \qquad \{3.0\}$$

If our present epoch is not unique in this regard, and why should it be, the age of the universe at any given time since seconds ATB must proximately be equal to the inverse of the Hubble parameter at the given time. Unfortunately, physicists hold that the Hubble parameter is approximately the same since ATB, with only slight variations. Accordingly, the inverse of the Hubble parameter has always been approximately 13.7Gy (e.g. even when the age of the universe was 1, 5, 7, or 10 Gy) with only slight variations resulting from the varying relation between matter and dark energy densities. An explanation is required according to this approach, to the uniqueness of our era, i.e. why the Hubble time according to the inverse relation{3.0}happens to be trustworthily the age of the universe only in special epochs, e.g. an epoch at which human beings exist and can doubt.

Taking the alternative, i.e. that our present epoch is not unique, I define as follows:

H_0 = Hubble parameter at the time of receiving a light arriving from a distant object.
He = Hubble parameter at the time the arriving light has been emitted
A_0 = the age of the universe at the time of receipt of the remote light
Ae = the age of the universe when the arriving light has been emitted
t = the time lapse between the moment light has been emitted and its moment of arrival = $A_0 - Ae$

$$H_0 = \frac{1}{A_0} \qquad \{3.1\}$$

$$Ae = \frac{1}{H_e} \qquad \{3.2\}$$

$$H_0 = \frac{1}{A_e + t} = \frac{1}{\frac{1}{H_e} + t} \qquad \{3.3\}$$

$$H_0 = \frac{H_e}{1 + H_e \cdot t} \qquad \{3.4\}$$

From {3.4} it follows that the Hubble parameter at the time of light arrival, is equal to the Hubble parameter at the time same light has been emitted, *He*, divided by $1 + He \cdot t$. It also follows that the Hubble parameter decreases in time, i.e. the expansion of the universe ever decelerates[I].

Note that ***He*** times ***t*** is equal to the elongation of a unit of distance from the time the light has been emitted and up to date. Accordingly, $\boldsymbol{1 + He \cdot t}$ is a today's length of an ancient unit of distance which has been expanded since the time the light has been emitted. Equation {3.4} can thus be interpreted as follows:

[I] I did not forget the evidences based on SN type Ia surveys which indicate to the contrary. I will ignore them in the present article since it is too early to show their flaw in view of MCS physics, but will return to discuss them thoroughly after advancing several necessary articles.

There is a constant elongation of space distances, since the big bang, and the constancy is in the amount of "units"[II] of space entering the universe per a unit of length per a unit of time, thereby causing space to expand in time. Note, that the amount added is constant in that it is always added per the **original** unit of length only, and not per its added value, i.e. the same amount of space units is added to our universe every second per each **initial** distance unit, i.e. the addition "ignores" the elongation of each initial distance unit which meanwhile occurs. This is in contrast to the conventional approach held by physicists who take H_0 as remaining nearly the same since ATB. According to their approach, the elongation of space distances is substantially constant, i.e. the elongation of space is not only per the initial distance, but also per its added value.

Actually, professors of physics love to use the "addition of space" explanation[III] as a metaphor, when teaching the Hubble expansion to students. I can only imagine why they hold this only a metaphor: if "units" of space itself are a "thing" added for making the expansion of space real, how can galaxies been dragged apart, while inertial motion tells us space has no drag effect on matter. But, as I mentioned earlier, if this is the problem, escaping to the "dark energy" solution solves nothing.

The aim is then, to search for a mechanism by which a "something" whatever it is, can interact with galactic matter for pushing it, without killing its rotational motion. Once the mechanism is discovered, space itself[IV] may be accounted for the "something" doing the magic, making dark energy redundant.

In my next article, titled ***Energy***, I will disclose a mechanism by which space have a drag effect on matter, surprisingly without killing its inertial motions.

But before diving to the understanding of the mechanism, the "addition of space" notion should be discussed in more detail.

A Package Deal: Inflationary Model of the Bang & Hubble's law

Influenced from Hubble discovery of what seems to be a correlation between redshifts and cosmological separations, the expansion of the universe is traditionally discussed in terms of elongation of space distances, and of course the Hubble parameter itself is determined as a ratio between distances. The universe, however, is expanding in all directions, i.e. volumetrically. Relating to the expansion as a result of "units" of space continually added in a predetermined rate in between existing "units", is actually equivalent to relating to it as the result of continuous addition of a predetermined space volume into an existing space volume, in a predetermined rate. The latter equivalent approach is more natural, however, since it treats the expansion in all directions at once, and sees the elongation of distances as an always true derivative of a one constant added volume of space entering the universe per a unit of time. As can be appreciated, starting from the elongation of distances as the origin of the increase in volume as conventionally suggested by Hubble's law, (in contrast of relating to the increase in distances as a derivative of an increase in volume, as suggest by me) requires an accountant that will seat there, count the added "units" and decide to the

[II] the nature of this "units" will be discussed in my next article, where they will be named as well.

[III] i.e. without linking their explanation to any specific formula or mathematical expression defining the variation of *He* in time, surely not to the one I've just managed to disclose.

[IV] without the help of any sort of energy to defeat gravity, as will be shortly discussed in more detail.

elongation of which spatial directions each unit is to be accounted for. The integration of the added "units" over time, will result in the addition of an ever growing volume of space added per a given time unit.

I therefore suggest to transform equation {3.4} of above to a volumetric version, and to try to associate between the age of the universe and the **volumetric** expansion of space by an inverse ratio similar to {3.0}.

Note, that whenever the increase *dL* in the length of a space unit *L* per a unit of time *dT* is sufficiently small (which is the case since fractions of seconds ATB), the addition of a space volume per a volume of a cubic space unit L^3 is equal $3L^2dL/dT$. If, as I assumed, there is a constant addition of space units per a given initial unit of length (say 1m) per a unit of time (say 1sec), at an epoch when Hubble parameter is equal H_0 there will be a constant addition of space volume $3\cdot m^2\cdot H_0$ into a cubic space of $1m^3$.

Accordingly, let the volumetric expansion of space be $\boldsymbol{vH_0}$, such that $\boldsymbol{vH_0 = 3\cdot} m^2\cdot\boldsymbol{H_0}$.

Assuming now that there is a constant volume of space constantly entering the universe since the bang, we can relate to each single cubic unit, say $1m^3$, as a compact representative of the entire universe, such that before the bang its volume was zero, and such that it has reached its current volume (one cubic meter) by a constant addition of $\boldsymbol{vH_0}$ since then. An inverse ratio between the volume of the universe (or units thereof) and its age is accordingly a very intrinsic law of nature.

We can now use our original argument (the one claiming our present epoch is not any special than ant other epoch since ATB) as follows:

$$A_0 = \frac{1}{vH_0} = \frac{1}{3\cdot m^2\cdot H_0}$$

{3.0.1}

$$vH_0 = \frac{1}{A_0}$$

{3.1.1}

$$Ae = \frac{1}{vH_e}$$

{3.2.1}

$$vH_0 = \frac{1}{A_e + t} = \frac{1}{\frac{1}{vH_e} + t}$$

{3.3.1}

$$vH_e = \frac{1}{A_0 - t} = \frac{1}{\frac{1}{vH_0} - t}$$

{3.3.2}

$$vH_0 = \frac{vH_e}{1 + vH_e\cdot t}$$

{3.4.1}

$$vH_e = \frac{vH_0}{1 - vH_0\cdot t}$$

{3.4.2}

The interpretation of {3.4.1} is that the addition in volume of space distributed into one cubic meter of space in one second today, is equal to the addition in volume of space distributed into an ancient cubic meter of space in one second at the time the light has been emitted (i.e. *t* seconds ago), divided by the number of cubic meters of space occupied today by the sum of said ancient cubic meter and the accumulative space added to it since then. Equation {3.4.2} allows to derive the vHe on any ancient epoch based on today's vH_0.

At the first second of the bang, the universe has been expanded from a **zero** volume (space does not exist) to the Hubble Constant Volume ***Hc***, which can be defined as the constant[V] volume of space exiting the virtual boundaries of the observable universe every second, due to the expansion. This means the expansion **rate** in the first fraction of second of the bang was enormous (∞ at the moment a first "unit" of space has entered the universe), and is decreasing ever since.

Inflationary model of the bang is thus inferred directly from the expansion of the universe as expressed by equation {3.4.2}: when *"t"* tends to be equal the age of the universe, the expression $1 - t \cdot vH_0$ tends to zero, thus vHe tends to infinity. As I indicate in the following section, this inflationary expansion does not require hypothesizing any additional factors such as inflaton field, since it occurred before the build up of gravitational fields.

Attention should be paid that for {3.4.1} to be true, the Hubble parameter of today, $\boldsymbol{H_0}$, must be one third of its widely accepted value, according to a 13.7Gy current age of the universe. Bear in mind, however, that the value of $\boldsymbol{H_0}$ is not measured directly rather determined based on a hypothesis that Hubble redshifts of receding galaxies are a linear function of the Hubble expansion. This hypothesis mainly relies on the commonly accepted notion that light waves can be "stretched" (as inferable from a conventional Doppler effect) so, why wouldn't light waves as simple as that be stretched by "dark energy" or by the stretching of space itself through which they propagate? Since the expansion of space is three dimensional, I expect proponents of the light wave stretching hypothesis to consider the possibility that the bunch of energy carried by a light wave is smeared due to the expansion of space during time, not only in the direction of propagation, but spatially as well. Accordingly, the elongation of space should be accounted for only one third of a Hubble redshift measured while lateral expansion of space should be accounted for the other two thirds. According to MCS Physics, however, a Hubble redshift has nothing to do with the expansion of space nor with stretching of light waves[VI], thus as far as MCS Physics is concerned it is straightforward to assume a 13.7Gy current age for the universe, and a Hubble parameter of one third of its currently accepted value. Moreover, based on SNe Ia surveys and further based on the greatest redshifts ever detected (excluding that of the CBR), best fit of MCS Physics model of cosmological redshifts reveals the age of the universe is probably much greater than 13.7Gy, perhaps 35Gy. Accordingly, my suggestion of above, i.e. that light waves are redshifted due to the expansion of space not only in the direction of propagation but

[V] Though according to {3.4.1}the expansion rate is constantly decreasing, the density of matter in the observable universe is decreasing respectively, thus *Hc* represent the amount of space which has entered the observable universe at the first second of the bang.

[VI] The mechanism resulting with cosmological redshifts according to MCS Physics will be disclosed and discussed in an article dedicated to the SNa1 surveys and to the accelerated expansion conventionally inferred from.

spatially as well, should be referred to only as urging the proponents of the light wave stretching hypothesis to reconsider their assumptions, and not as an assumption I can agree with.

Gravity-free Inflation

Taking one step further the idea that the Hubble expansion of the universe is a result of a constant addition of a Hubble volume, i.e. of a gargantuan constant number of infinitesimal space "units" entering the universe every second since the bang, I postulated in the previous section that the bang itself is a result of exactly the same space addition rate as experienced by our today's universe, with the exception that at the start of the bang a first dose of space has been entered a nil universe, i.e. a universe possessing a zero volume space, while since then the same dose is entering an accumulative volume thereof. As will immediately become apparent, the bang has occurred in a gravity free universe, thus the entering space itself, without the help of any energy content (such as inflaton field and the conventionally hypothesized vacuum energy), was able to drag apart the elementary particles attended[VII] the bang. As will later become apparent, despite of the appearing of gravity a fraction of a second later, no energy content is required in space in order to make galaxies recede as well.

It can thus be appreciated that the Big Bang is not a historical event. It continues in the same manner and in the same constant rate, since the first Hubble volume of space units suddenly appeared some 13.7Gy ago and dragged matter apart.

One difference between then and today is, as already mentioned, that today the same volume is added to the accumulative volume ever added since then, while at the first moment the Hubble volume has entered a void and caused the universe to expand from zero to the respectively gargantuan Hubble volume within a fraction of a second. Another difference is between the conditions which provided for an energy free dragging apart of elementary particles in the first fractions of a second of the bang, and the conditions which provide for today's energy free dragging apart of receding galaxies. These will be discussed shortly hereinafter in this article, and in more detail in articles to follow.

Instead of defining the Hubble volume as the volume of space entering the universe in one second, it will be more useful to define it in natural units. As far as the first bang moment is concerned, a natural unit may be defined as the volume entering the universe within a $T_1+ T_2+T_3$ time frame[VIII], which is the time it takes every *EMP* in the universe (and every elementary generator of fields other than gravity) to contribute its influence to the buildup of gravitational (and any other) fields associated with elementary particles. In said tiny time frame, i.e. within a fraction of a second, the volume of the universe has expanded from zero to a Hubble volume natural unit (hereinafter $<H>$), dragging apart and substantially homogeneously all the elementary universal particles, before they had the chance to interact by fields, i.e. to respond to fields. Only during T_3 the interaction between particles may have started to occur, while particles continue to recede (though in a decreasing rate) due to the significant

[VII] According to MCS Physics the elementary particles preceded the bang, but were unable to interact due to the absence of space

[VIII] see Article 2: *EMP* and Time

effect every added dose of <*H*> had, in terms of elongation of separation distances, when the volume of the universe was only several <*H*> volumes.

As you may appreciate, by trusting equation {3.4.2} for any time duration *"t"* up to the age of the universe, we get a package deal, including a built in inflationary model of the bang, and a universal expansion, making redundant any sort of inflaton field and any sort of dark energy. A mystery yet remain, why and from where space units pop up into our universe. These are questions that, to my appreciation, may never be answered within a scientific framework. It can be guessed that space "units" appear from dimensions extra to the three we are familiar with. Note that when the time ***t*** in the equation {3.4.2} is greater than the age of the universe, *vHe* receives a negative value:

$$vH_e = \frac{vH_0}{1 - vH_0 \cdot t} \qquad \{3.4.2\}$$

This may be considered a hint to the existence of a "behind the wings" pre bang universe which shrinks for making ours inflate, for those of us who find interest in speculations.

Why and from where *EMP*s (or any other elementary particles) were present in the primordial space-free universe prior to the bang are also questions that, to my appreciation, may never be answered scientifically. I can only imagine, by way of analogy, that evolution of elementary particles from some primordial immaterial[IX] staff, has occurred prior to the bang, and is not likely to reoccur in a space possessing universe. This is in analogy to the evolution of the ancient forms of life in oceans, which had the chance to occur in an oxygen free atmosphere, and which produced our oxygen enriched atmosphere, which in turn inhibits the repeat of the early stages of the evolution of life.

As can be appreciated, during the initial field generating cycle practiced by elementary particles firstly exposed to space, the addition of <*H*> in between particles, dragged them apart without experiencing any resistance, i.e. without investing energy, because force fields have not been built up yet.

Gravity is Volumetric

In the previous section, I postulated that the big bang has started without gravity, thus space entering the universe in between particles was able to drag them apart. This does not explain how space addition in between receding galaxies can defeat gravity and drag galaxies apart, without consuming energy.

According to MCS Physics gravity is a phenomenon of space itself (and in this notion it is equivalent to GR). Since space is a 3D continuum, at least in particles level scales and up, MCS Physics claims, differently than any other theories of gravity, that

[IX] i.e. staff which probably has interactions of its own (inside the hidden "engine rooms" of particles), from which both Newtonian mechanics and Quantum mechanics evolve, but which does not obey any of the nature rules governing the outside world (i.e. exteriorly to the "engine rooms" of elementary particles).

gravity does not propagate through space in straight lines. As a phenomenon of space itself, it propagates volumetrically, i.e. by filling up space with an influence generated by mass, i.e. by *EMP*s. This part of the mechanism, by which "matter tells space how to curve" as John Wheeler famously used to describe, will be discussed in detail in articles to follow, and will be confirmed by strong observational evidences.

If this is true, gravity has no specific speed. Near matter, at small radiuses, the space enveloping a central mass is small, thus being filled up swiftly by the generated influence. Depending on the amount and the density of the mass generating the field, the distribution speed of gravity may thus be indefinitely high[X] near matter. As the distance from the mass becomes larger, the distribution speed of gravity is dropped down, and as can be appreciated, in cosmological large scales, where the volume of space enveloping the mass is sufficiently large respective to the amount of mass enveloped by, the distribution speed of gravity becomes smaller than the elongation rate of distances according to Hubble's law.

Galaxies which are sufficiently distant, are thus gravitationally unbounded, thus recede by the Hubble addition of space which drags them apart without involving any sort of energy. Since no inertial motion is changed and since no gravitational attraction opposes the drag, no energy is required for the process to occur.

Article sum up

The universe exhibits addition of space volume in a constant rate since the bang. The bang, its inflationary nature in a fraction of its first second, and the Hubble expansion are all one continuum of the same said phenomenon.

In volumetric terms, the Hubble parameter varies in time according to the following formulas:

$$vH_0 = \frac{vH_e}{1 + vH_e \cdot t} \qquad \{3.4.1\}$$

$$vH_e = \frac{vH_0}{1 - vH_0 \cdot t} \qquad \{3.4.2\}$$

Gravity is a phenomenon of space itself, and as such it is distributed volumetrically (i.e. not in straight lines)

The **speed** of gravity is proportional to the amount of mass generating it and is inversely proportional to the square of the distance from the mass

A certain distance from the mass, the decaying speed of gravity becomes smaller than the Hubble elongation rate of distances. The result is gravitationally unbounded galaxies receding according to Hubble's law (more accurately, according to a modified Hubble's law suggested by MCS Physics)

It takes time, i.e. one particle cycle, for an EMP to build up its gravitational field

The big bang started in a universe free of gravity, first, since gravity is a phenomenon of space, thus without space there is no gravity, and second since it took one *EMP*

[X] Yes, faster than light, but involving no distribution of energy. Space "units" are energeticless, and gravity is a property of space. Space can propagate faster then light.

cycle for the elementary particles attended the initial addition of $<H>$, i.e. the bang, to build up gravitational fields and to respond to them.

In the absence of gravitational fields no energy was required for dragging apart all universal matter and distributing it homogeneously throughout the pumped in space, for vast distances in terms of elementary particles.

Based on Feynman's argument in rejection of Fatio/Le-Sage's gravity, the "something" that drags galaxies apart according to Hubble's law must do the magic without killing inertia. If this selective drag can be explained in terms of space itself (i.e. independently of vacuum energy, cosmological constant, quintessence energy, or the like), the postulation of dark energy is redundant.

Glossary

He Hubble parameter at the time the arriving light has been emitted

$\boldsymbol{vHe}$ the volumetric Hubble parameter at the time the arriving light has been emitted

H_0 Hubble parameter at the time of receiving a light arriving from a distant object.

$\boldsymbol{vH_0}$ the volumetric Hubble parameter at the time of receiving a light arriving from a distant object

A_0 the age of the universe at the time of receipt of the remote light

Ae the age of the universe when the arriving light has been emitted

$<H>$ Hubble volume entering the universe within $T_1+ T_2+T_3$ time frame of an *EMP*

Hc Hubble volume entering the observable universe within one second

References

[1] Anna Frebel, Norbert Christlieb, John E. Norris, Christopher Thom, Timothy C. Beers, Jaehyon Rhee, Discovery of HE 1523-0901, a Strongly r-Process Enhanced Metal-Poor Star with Detected Uranium (2007); arXiv:astro-ph/0703414v1

[2] Richard Feynman, The Character of Physical Law(1965), MIT Press (1985) p. 39