9 - Propagation of light across large distances.

Version 9.0 (1-Feb-2021) a new Tempo Rate Law is proposed.

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Abstract

Hubble's law can be explained by the model, without invoking an expanding Universe, as the consequence of a slow gradual increase of all the speeds of all the bound bodies (elementary particles, planets,...) of the Universe. Those increasing speeds include orbiting and oscillation speeds of the bound bodies. The speeds increase in relation to the speeds of the aetherinos of the aether.

Introduction.

Imagine an intelligent supernatural being, who will be called "IO" (Ideal Observer), that observes our physical world (the Universe).

IO observes that the space of the physical world is "full" of a special kind of point-like "particles" that move in all directions, with a wide variety of speeds, that collide with the standard material elementary particles of Physics. He calls "aetherinos" those point-like particles unknown by mainstream physics.

IO finds that he can describe the evolution of the physical world using "Absolute Time". He classifies all the events of the physical world assigning them a number that he reads in his "absolute clock". (An "event" is in this context a specific distribution of the space locations of *all* the particles of the Universe).

IO knows the position of all the particles of the Universe instantly (without waiting for any "radiation" to reach him).

IO also finds that there exist reference frames (called rectilinear) in which all the aetherinos move in straight lines at constant speeds. IO realizes that any given aetherino moving through space can be used to define the clock for his description simply postulating that the time elapsed is given by the distance (multiplied by some constant) traveled by such aetherino. IO decides to pick one of those aetherinos and use it as his (absolute) "clock".

Since, by hypothesis, a reference frame can be found in which all the aetherinos travel at constant velocities (as long as they do not collide with matter) then there exists an infinite number of *rectilinear frames* because any reference frame moving at constant velocity relative to another is also a rectilinear reference frame.

The absolute time defined by the clock of the Ideal Observer (IO) with which it is observed that all the aetherinos travel at constant velocities will be called the *Ideal Time.*

We, the observers within our world, are not able to "see" the aetherinos (because the aetherinos are the entities that compose the light-type disturbances) and therefore we make use of another phenomena, based on the oscillation of our observable material particles (e.g. on atomic clocks), to define the time readings (or instants) with which we describe the physical world. (It will also assumed that our

physicists are also able to make a consistent description of Physics postulating, like Newton, an "absolute time" and therefore, in what follows, the reader should not get tangled with the Special Theory of Relativity).
An observer that, for his description of Physics, assigns the "time" of the events with the atomic clocks of the physical world will be called an Official Observer (OO).

Both IO and OO share the same space (e.g. length) standards.

Suppose now that the Ideal Observer IO observes that the *tick rate* of all the atomic clocks of the Universe increases gradually (as measured by his "aetherino clock").
Suppose also that IO observes that the Universe is not expanding (i.e. its galaxies are not flying apart). In spite of that, the IO observer will reason (as explained below) that the OO observers must be observing that, the *farther* is a galaxy from them, the *smaller* are the frequencies of the spectral lines in the light coming from the galaxy (that correspond to the well known atomic transitions of mainstream physics). (i.e. IO realizes that the OO astronomers must be observing Hubble's law).

Since, as explained in previous sections, the aetherinos give impulses to the elementary particles of matter when they collide with them and since an aetherinical impulse produces a (small) velocity change in the elementary particle suffering the collision (the velocity change is more precisely a *velocity increase* in the semi-direction of the *relative* velocity of the incident aetherino) then the model must assume that the aether *tends* to decrease the speed *relative to the aether as a whole* of the material particles of matter that move relative to it. This is called in the model *the aether drag*.
But it is also explained in other sections of this work that the existence of the aether drag ***does not*** imply that the *bound* material particles and bodies of the universe *actually* decrease their speeds relative to the aether because there exist other material forces that counteract the tendency of the aether to slow down the bodies. More precisely: when a material particle or body is orbiting another massive body due to the *attraction* force that this body exerts on the former the attraction force is not fully central but has a component along the instantaneous orbital velocity of the orbiting body that tends to increase the orbital speed of the body. This force component that is called the “forward force” is, in the stable orbits, exactly cancelled by the aether drag force and thus the orbital speed is not increased due to the forward force. (Note: the *forward force* can be understood considering that the more efficient aetherinos responsible of the material force between two bodies have a finite speed close to c relative to the orbiting body suffering the studied force and therefore the direction of the velocity of those speed-c aetherinos relative to the orbiting body is not exactly equal to the direction “center of force”-“orbiting body” but is deviated (aberration) relative to it. But since the orbiting body suffering an attraction force measures a *deficit* of aetherinos coming from the center of force then the impulse due to a missing aetherino tends to increase (instead of decrease) the speed of the orbiting body. And it must now be realized that the great majority of the bodies and particles of the universe are subject to attraction forces (gravitational or electro-atomic) exerted by other more massive material bodies around which they are orbiting.
Those moving (relative to the aether) bodies that are not bound by the attraction forces of other bodies will indeed be slowed down by the aether drag force (since they do not suffer an opposing forward force) but (1) these “free” moving bodies are a minority and (2) the parameters of the aether model can be adjusted to make the aether drag force very weak so that the slowdown of the free bodies can be neglected in many scenarios. (Note: the main parameter that must be adjusted to minimize the aether drag force is the average speed of the aetherinos of the aether. More precisely calling V_M the speed for

which the speed distribution of the aether has a maximum number of aetherinos, then increasing V_M will decrease the aether drag force in comparison with the other material forces of Physics).

Note: some evaluations have been made (e.g. see AOE.nb) that show that, according to the model, only some atomic orbits are stable. But at this stage (2014), the model does not predict the correct electronic orbits (energy levels) of the atoms to account for the experimental facts, not even in the simple case of the atom of Hydrogen. (P.S. some suggestions related with the stable electron orbits of the Hydrogen atom can be found in the paper https://www.eterinica.net/EVE10/Eve10.pdf).

Let V_M be the speed for which the distribution of aetherino speeds of an undisturbed aether has a maximum number of aetherinos. Suppose that, by some reasons, both the speed of light c and the speed V_M increase slowly with the epoch as measured by the Ideal Observer. This slow increase of c and V_M is supposed to happen at approximately the same rate all across the Universe. The increase of V_M must not be interpreted as a gradual increase in the speed of the aetherinos while they travel freely through space but as the result of their interaction with matter (i.e. when the aetherinos collide with matter they emerge from the collision, on the average, at higher speeds. This would occur mainly in the nuclear reactions taking place in the stars.). But any given aetherino maintains its IO velocity until it collides with matter. The increase of the speed of light observed by IO would be a consequence of the increase of V_M assuming that: (1) the speed of light is the speed of those aetherinos that are more efficient (sharp resonance in the electron's cross section to aetherinos) in producing impulses on the electrons when they collide with them, (2) the efficiency of those collisions would depend on the relation between the speed of the aetherinos and some intrinsic oscillation speed (and hence intrinsic frequency) of the electrons, (3) such intrinsic oscillation frequency of the electrons would increase at the same rate that the V_M of their local aether increases.

It can be seen in the AOE.nb evaluations that if the values assigned to c and V_M are increased in the same proportion, for example becoming respectively k c and k V_M, the stable atomic orbits predicted by the model occur at the same distances from the nucleus but are performed at an orbital speed k times bigger than before, as observed by IO. The Official Observers (OO), that base their "time standard" on some observable intrinsic frequency (or wave length) of their local atomic clocks will therefore not notice any long term change in the speed of light neither (first-order) changes in the behavior of their local atoms.
Furthermore, due to the same nature of the aetherinical forces between all kinds of matter, it is expected that when V_M and c are increased in the same proportion, the orbiting speed of *all* the material bodies bound by attraction forces (including not only atomic electrons but also stars, planets, satellites,... bound by gravitation forces) should increase for IO at the same rate that V_M and c increase. The oscillation frequency of bound systems of particles should also increase (for IO) at the same rate.

Supposing that at a given epoch the constants being called c and V_M have, for the Ideal Observer, the respective values c_1 and V_{M1}. Then if this Ideal Observer calculates (from the equations of the model) the aetherinical force between two particles (separated by some given distance and with some given relative velocity) he will find that this force has some value that will be called F_1. Suppose next that at a later epoch (e.g. thousands of years later) those constants have, for IO, the respective values $c_2 = k\ c_1$ and $V_{M2} = k\ V_{M1}$ (i.e. both speeds have increased in the same proportion); then the model shows (see for

example the AOE.nb evaluations) that the force between those two particles will have (for IO) a value $F_2 = k^2 F_1$. Therefore if one of the interacting charged particles has a mass m it will suffer (as seen by IO) in the first epoch an acceleration $a_1 = F_1/m$ while in the later epoch it will suffer (as seen by IO) an acceleration $a_2 = F_2/m = k^2 F_1/m = k^2 a_1$ Therefore, in the earlier epoch the particle of mass m, initially at rest, suffering a constant force will travel, with uniform acceleration, a distance d in a IO time interval $\Delta\tau_1 = (2d/a_1)^{1/2} = (2d\ m/F_1)^{1/2}$ (because a body, initially at rest, suffering a constant acceleration *a* travels in a time interval $\Delta\tau$ a distance $d = 1/2\ a\ \Delta\tau^2$).
In the later epoch in which the aetherinical force between those bodies is (according to IO) $k^2 F_1$ the uniformly accelerated particle of mass m will need, to travel the same distance d, a IO time interval $\Delta\tau_2 = (2d\ m/(k^2 F_1))^{1/2} = (1/k)\ (2d\ m/F_1)^{1/2} = (1/k)\ \Delta\tau_1$ But in this later epoch the *local* atomic clocks of the Official Observer run k times faster and therefore OO will *observe* that the particle travels the distance d in the same OO time interval as in the earlier epoch.
Therefore if OO assumes in his description of physics that the strength of a force is given by $F = m\ a$ (Newton's 2nd law), he will observe that, under the same initial conditions, his forces do not vary with the epoch.
The guess is that the Official Observer using his local atomic clocks will not observe any (first order) changes with the epoch in any of his local laws of Physics.

But when the Official Observer looks at distant galaxies he is observing phenomena that occurred a long time ago when the atoms of those galaxies were "living" at a smaller rate compared to the present rate of the atomic clocks of the earth's observer. He (OO) will therefore observe a red shift in the spectral lines of those far away atoms. The farther from Earth is the observed galaxy, the greater will be the observed red-shift since that implies that the earlier will be the epoch at which the galaxy emitted the light being now observed.
Remember also that, according to the model, the more effective aetherinos in triggering the detectors of light are those of speed c *relative to the material detector*, (not necessarily c relative to the frame of description). (According to the model, the speed of light in vacuum has a constant value c relative to the detector that does not depend on the velocity of the detector or the emitter relative to the aether and neither on the velocity of the detector or the emitter relative to the frame of description. In a Galilean scenario this speed constancy can be implemented assuming that every light emitter "emits" radiation-modulated aetherinos at a *plurality* of speeds relative to the emitter but only those of speed c relative to the material detector are effective in transmitting the modulation of the wave).

In what follows, the letter τ will be used to represent the time variable (clock readings) of the IO observer and the letter *t* that of the OO observer.

Suppose that at a given instant, for example "today" (epoch of our measurements of the redshifts of the celestial bodies), we synchronize the IO clocks with the OO clocks setting their time readings equal to $\tau = t = 0$ and equating their time interval units. The light that we receive *today* (at the present epoch in which we have synchronized the IO and the OO clocks) from any distant galaxy has traveled all the way at a constant speed *c* for the Ideal Observer (since the aetherinos travel for IO at constant speeds and since those that trigger our light detectors are those of speed c as seen by OO and also, at the present epoch, as seen by IO, due to the mentioned synchronization of clocks). If the distance between the emitting galaxy and the Earth is (and has always been) *d* then the light activating today's Earth's detectors departed the galaxy at the IO epoch $\tau_E = -d/c$

Let the function f(τ) describe the increase with the epoch, observed by IO, of the speed V_M (characterizing the aether distribution). As proposed above, this same function f(τ) would also describe the increase with the epoch, observed by IO, in the speed of light and in the orbiting speeds of most bounded particles and bodies.

(It must be insisted that the aetherinos, while traveling through space without colliding with matter, do not vary their velocity as seen by the Ideal Observer IO. The disturbance that a given detector D_1 will detect as light is transported by aetherinos of a constant speed v_{I1} (as seen by IO) which is such that, when those aetherinos reach the given detector D_1, the clocks of the Official Observer that are *close* to the detector are advancing at a rate such that OO assigns to those aetherinos a speed equal to c (i.e. to $3*10^8$ m/s). But there may exist at the same time another "flow" of aetherinos traveling through space at a bigger but also constant speed v_{I2} (as seen by IO) that do not reach the detector D_1 but encounter at a later epoch another detector D_2 and manifest itself "as light" because at this later epoch the clocks local to the detector are oscillating faster (as seen by IO) and it again happens that such v_{I2} speed is seen by OO as c).
Considering that the Official Observer always measures locally that (1) the speed of light has the constant value c, (2) the speed characterizing the distribution of the canonical aether has always (for OO) the constant value V_M and (3) that the orbital speeds of the electrons of his atoms no not vary (for OO) with the epoch, then synchronizing the IO and the OO clocks (so that for example t = 0 at τ = 0) and synchronizing their rates at this epoch, and considering that both observers IO and OO share the same space standards (x, dx,…) the increase with the epoch observed by IO in those typically constant OO speeds can be expressed as:

[9-1]
$$u_I[\tau] = u_I[0]\,f[\tau] = u_O\,f[\tau] \quad \Rightarrow$$
$$\frac{dx}{d\tau} = \frac{dx}{dt} f[\tau] \quad \Rightarrow$$
$$\frac{dt}{d\tau} = f[\tau]$$

where the sub index I denotes "as measured by IO" and the sub index O denotes "as measured by OO". Notice also that the speed v of an aetherino (that does not vary for IO) varies with the epoch for OO according to $v_O[\tau] = v_I/f[\tau]$

Since f[τ] relates, at the epoch τ, the rates of the IO and the OO clocks it will be called a "*Tempo rate law*".

Note: More precisely, the Tempo Rate Law dt/dτ = f[τ] describes, at a given epoch, the ratio between the time interval assigned by OO to a pair of events (instants) and the time interval between those same events assigned by IO, using his clock.
Notice that a Tempo Rate Law dt/dτ can be expressed as a function of the IO epoch τ (like in f[τ]) or as a function g[t] of the OO epoch *t* (For example, g[t] can be deduced from f[τ] integrating the differential equation dt/dτ = f[τ] to obtain the relation t[τ]; deducing from it the relation τ[t]; and replacing this last in f[τ[t]]).

A simple hypothesis for the **Tempo Rate Law** that relates in our world the rate of the IO clock to the rate of our standard OO clocks is:

[9-1b] $$\frac{dt}{d\tau} = e^{\mu t}$$

that, with the boundary condition $\tau = t = 0$, gives

[9-1c] $$t = -\frac{\mathrm{Log}[1-\mu\,\tau]}{\mu}$$

and therefore the *Tempo Rate Law* $dt/d\tau$ as a function of τ becomes (replacing [9-1c] in [9-1b]):

[9-1d] $$f[\tau] = \frac{dt}{d\tau} = \frac{1}{1-\mu\,\tau}$$

According to the description made above, the radiation arriving today τ=t=0 to our telescopes from a galaxy, located at a distance *d* from the Earth, departed the galaxy at the IO epoch:

[9-2] $$\tau_E = -\,d\,/c_I[0] = -d/c$$

where c is the speed of light in vacuum (approximately $c = 3 * 10^8$ m/s).

The red shift z of a radiative atomic transition is defined as:

[9-3] $$z = \frac{\lambda_R - \lambda_0}{\lambda_0} = \frac{\lambda_R}{\lambda_0} - 1 = \frac{\nu_0}{\nu_R} - 1$$

where

ν_0 is the frequency of a given atomic transition (a given spectral line) measured in the proximity of the source (in the lab) by a detector at rest relative to the emitter and

ν_R is the observed shifted frequency of that specific spectral line when its light comes from a distant source and is measured at the Earth.

According to the observational facts the law of Hubble is:

[9-3b] $$z = \frac{H_0\,d}{c}$$

where

d is the distance at which was the source from the Earth when the light that we are now observing was emitted, and

H_0 is the Hubble constant whose experimental value is approximately

[9-3c] $$H_0 \cong 75\ \mathrm{Km\ sec^{-1}\ Mpc^{-1}} \cong 2.5 * 10^{-18}\ \mathrm{sec^{-1}}$$

At the old epoch τ_E = -d/c when the light departed the far away galaxy, the electronic orbits of the atoms were performed (as seen by IO) at slower speeds than today. The frequencies (as measured by IO) of the spectral lines are supposed to be directly proportional to the orbital speeds of the atomic electrons.
A generic orbital speed that has today (t = τ = 0) the value u[0], had in the epoch τ_E the IO value:

[9-4] $$u[\tau_E] = u[0]\, f[\tau_E]$$

and hence, if today, in the epoch τ=t=0 the IO observer measures in some given spectral line the frequency $\nu[0] = \nu_0$, in the epoch τ_E he would measure for that spectral line the frequency:

[9-5] $$\nu[\tau_E] = \nu[0]\, f[\tau_E]$$

Realizing that the frequencies called in [9-3] ν_R and ν_0 are equal to respectively $\nu[\tau_E]$ and $\nu[0]$, and assuming, by hypothesis, the Tempo rate law $f[\tau] = 1/(1- \mu\, \tau)$ then [9-5] becomes:

[9-6] $$\nu_R = \nu_0 \frac{1}{1-\mu\tau} = \nu_0 \frac{1}{1+\mu\, d/c}$$

and the red-shift [9-3] is therefore

[9-7] $$z = \frac{\nu_0}{\nu_R} - 1 = \mu\, d/c$$

that represents the *cosmological red-shift law* proposed by the model.

This expression [9-7] of the red shift in the spectral lines of distant atoms is equal to Hubble's law *if it is supposed that the constant* μ *has a value equal to Hubble's constant* H_0, or more precisely equal to:

[9-8] $$\mu = H_0 = 2.5 * 10^{-18} \text{ sec}^{-1}$$

Assuming that the systematic cosmic red shift is due to the Tempo Rate Law described above and not to an expansion of the Universe, then it may be asked:
The light that we receive today at the Earth from a galaxy located at a distance d from us, what speed did it had at the epoch of its emission when measured by the local OO atomic clocks of the galaxy? The answer is as follows:
The IO epoch of emission of such light is τ_E = -d/c and at that epoch the atoms and hence the OO atomic clocks of the galaxy were running much slower than today as measured by the Ideal clock. The rate between the galaxy's atomic-clocks time t and the Ideal time τ (based on aetherino travelled distances) was actually

[9-9] $$\frac{dt}{d\tau} = \frac{1}{1-\mu\, \tau_E} = \frac{1}{1+\mu\, d/c}$$

and therefore the aetherino flows that trigger today the light detectors of the Earth (because of their speed c), had at the epoch of their emission a speed c_E (measured with the OO atomic clocks of the galaxy) such that:

[9-10] $c_E\, dt = c_{EI}\, d\tau$

where c_{EI} is the IO speed of those flows of radiation and hence, since $c_{EI} = c$ and using [9-9]:

[9-11] $c_E = c_{EI}\, d\tau/dt = c\, d\tau/dt = c/f[\tau_E] = c\,(1+\mu\, d/c)$

For example, the radiation received at the Earth from a galaxy distant 5000 Mpc (and therefore seen with a $z = H_0\, d/c = 1.25$) has been carried by a flow of aetherinos that in the epoch of emission had a speed, as measured by the OO local atomic clocks of the galaxy, equal to:

$$c_E = c\,(1+\mu\, d/c) = c\,(1+ H_0\, d/c) = 2.25\, c$$

(Notice that in that older epoch in which emerged from the distant galaxy the disturbance that we detect today at the Earth as light, those aetherinos of OO speed $c_E = 2.25$ c *were not* the aetherinos triggering the light detectors at the galaxy. The aetherinos triggering the light detectors at that epoch (and at all epochs) were those of OO speed equal to c).
According to the model, the common sources of radiation emit light-modulated flows of aetherinos in a wide number (a plurality) of speeds relative to the emitter. But (see for example the Fig[R-10] of the paper "Redistribution of aetherino speeds"), since the redistribution of aetherinos created by matter becomes very weak for speeds bigger than, say, 2c relative to that matter, it is expected that the pertinent radiation flows of the example galaxy (corresponding to aetherinos of speed c_E= 2.25 c relative to the emitter) will be also very weak. But on the other hand the clouds of gas and dust of the galaxies are, plausibly (as suggested by the model) highly transparent to the radiation flows of speeds significantly higher than c (like is here the case of the c_E speed). Furthermore, the interstellar gas of the emitting galaxy will, according to the model, reemit at other speeds (including c_E and hence reinforcing it) part of the “normal light” (normal from the local point of view of the galaxy and hence of speed c relative to it) that this gas absorbs. (See more in the paper "Quasars" of this work).

This model of the aether is therefore able to explain that in a non-expanding universe one may also observe red shifts (related with the distance) in the spectral lines from distant sources. In other words, there is no need to assume an expanding universe and a Big Bang to explain the Hubble redshifts. The Universe could be (1) basically stationary (in a continuous process of creation and destruction of stars), (2) non expanding nor contracting (but subject to a hierarchy in which all celestial bodies are gravitationally orbiting other more massive bodies) and (3) plausibly infinite in size and age.
These possibilities seem important considering that the Big Bang cosmology has some controversial issues (e.g. An ad hoc inflation period needed to be assumed in the theory to remove some inconsistencies between the age and size of the Universe; According to some cosmologists it is difficult to explain the existence of well formed galaxies in very early epochs after the Big Bang; Although General Relativity explains that it is the space itself that expands (and not the bodies that explode away) it is still not clear at what level in the hierarchy of the celestial bodies (galaxies?, clusters of galaxies?, super clusters of galaxies,…?) does gravitation counteract the presumed expansion of its constituents,…).

Proposed test of the model.

The interpretation proposed above, based on a Tempo Rate Law, predicts not only the cosmic redshifts but it also predicts that the orbiting speeds of most bound bodies (e.g. of stars around their galaxies) increases with the epoch. This implies that, when observing galaxies of equal type and size at different distances from us, we should observe that the farther the galaxy the smaller is the average speed of its stars. Doing those observations would constitute a test of the model.

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NOTE: A suggested experiment.

CMBR = Cosmic Microwave Background Radiation
MR = Microwave Radiation.

But assuming a non-expanding universe as the most simple hypothesis the problem is now to explain the CMBR (Cosmic Microwave Background Radiation) without a Big Bang.

An intuition is that the CMBR is just the "noise of the aether" that by its very nature is able to "activate" detectors of radiation. The random collisions of the aetherinos of an undisturbed aether with a detector would behave as a blackbody type distribution of frequencies. If that were so, then the CMBR is not coming from the depths of the universe but should be detectable everywhere where the aether is present. For example a detector oriented to some direction where we have placed a screen that shields any hypothetical microwave radiation coming from the outer space, should also detect microwave radiation of the CMBR type (blackbody of 2.7° K).

It is suspected that no experiment has yet oriented its detectors to a screen able to shield the MR (Microwave Radiation) from outer space, because material screens are in general much hotter than 2.7° K and emit so much blackbody radiation that it would be a hard task to deduce if the screen is shielding or not the CMBR. But perhaps a specific experiment can be designed to solve that problem; perhaps enclosing a detector of MR in a container made of a material that is known to shield the MR from the outside, and cooling both the container and the detector below 2.7° K.

Another feature that should be experimented inside that cold shielding container is the *anisotropy* of the observed radiation (using a detector with good angular resolution and able to observe in all directions of space). The prediction is that the MR detected inside the container should have an anisotropy coincident in direction and "speed" to the one that has been observed in the CMBR of the sky. That is because the aether model interprets such anisotropy as due to the velocity of the detector relative to the aether and this effect should not be affected by enclosing the detector in a container since the great majority of the aetherinos (like do the neutrinos) penetrate big amounts of matter without colliding with it (and therefore without changing their velocities).