FROM COSMOLOGY TO PHYSICS

COSMOPHYSICS

ESSAY ON

A NEW NEWTONIAN PHYSICS THEORY

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NOTICE

Under the mysterious title Cosmophysics – it had to have it a name – hide only a few simple and commonsensical ideas that once all glued together seem to form, in my opinion, a coherent mix. In a strictly Newtonian frame of thought these ideas will allow me to rederive, using a classical method, the results of special relativity with the exception of the constancy postulate and the universality of the speed of light, two ideas I am challenging.

I am submitting these ideas to the scientific world, and my ears are wide open to any suggestions and criticisms that will arise.

INTRODUCTION

Let us will start with cosmology and proceed with a standard Newtonian approach towards a new kind of physics that describes the physical universe in the best possible way.

The term "cosmophysics" is best suited for my objective: to intimately link cosmology to classical physics.

The paradox is obvious since without physics there is no cosmology. The basic physics needed to establish the cosmology proposed here, is standard and agrees with the results established in the end of the 19^{th} century, namingly Maxwell's theory of electromagnetism and the well-known Michelson experiments. These experiments, in my opinion, do not "prove" the universality of the speed of light **c**, one of the "hypothesizes" of special relativity; they simply demonstrate that the speed of light is invariant to an observer in an earth-based laboratory. As far as I know, the direct measure of the speed of light was done only on Earth or in an area very close to it on the cosmic scale; nothing proves that is has the same value in another area of the universe.

My article breaks down into three parts:

- a simple cosmological study in Lagrangian coordinates that will allow us to bring forth an analogy between the speed of sound and the speed of light. Starting from the hypothesis of the big bang we will derive solutions to the hydrodynamic equations, in particular those corresponding to a uniform expansion where a Galilean referential can be defined in any point of the universe.

- an in-depth study of the mechanics of the material point, more complex than Newton's but still very general since it doesn't depend on the universe considered.

- finally the introduction of an intermediate transformation, somewhere in between Galileo's and Lorentz's, that agrees with Maxwell's equations for galilean referentials (where electric "charges" move with uniform speed) in perfect coherence with the previously established mechanical models: the physical existence of universal time and a transformation of lengths that respects the dilatation of the universe.

The main hypothesis fits in naturally in the frame of newtonian cosmology.

The starting hypothesis is a finite universe with a spherical geometry and a uniform mass density[1].

Using the conservation equations of hydrodynamics we will derive a simple model of a big-bang type expanding universe.

At first sight, there are many possible solutions but I will focus on the uniformly expanding universe that introduces non-fictitious galilean referentials, meaning that they have a physical existence.

A new hypothesis where the Newton's constant is proportional to $\mathbf{c^2}$**,** to the radius of the universe **R** and inversely proportional to the mass of the universe **M** will enable me to

[1] If course the existence of galaxies and the fact that our galaxy is situated in the Milky Way is not taken into account here

considerably simplify the math and give a simple physical interpretation of the mass-energy equivalence law E # mc^2 previously established in the theory of special relativity, which we can derive: the rest mass energy moc^2 represents an essentially **gravitational** energy.

I will then go on to show the formal proportionality between the speed of sound and the speed of light, which will us the form of its variation with the Lagrange coordinate; we must abandon speed of light's universal character as well the commonly accepted hypothesis of zero pressure in any point of the universe.

This new form of Newtonian cosmology will allow me to define, in agreement with the physical concepts of the big bang and the singular point:

- **a tridimensional absolute Euclidean space**
- **a universal time t**

It is therefore implicitly supposed :

- the existence of the **big-bang** and the expansion of the Universe
- the possibility to define at the instant of the big bang (time zero) a system of Cartesian coordinates, centered at the singular point defined by the big bang. At this time zero, space is void of matter everywhere, but not of *ether*, except at the center where the Universe is concentrated.

In rational mechanics or in special relativity, it is supposed that the laws of physics are valid independently of the considered universe and especially independently of its mass, which is always considered null (empty universe)

My point of view is different since I suppose that the Universe reacts on these laws and therefore transforms them.

In this non-empty and anisotropic Euclidean universe I will demonstrate how Newton's second law transforms. This transformation is independent of the considered universe, meaning it is independent of its constants (**c, R, M**).

The movement of the material point (including the photon) in the absence of force can be shown as periodical and moves on an ellipse which, in a mobile referential linked to the expansion, is centered on the center of the universe Ω.

The universe itself behaves as a huge black hole, which allows us to look for a simple physical interpretation of the "**limit speed**" character of the speed of light. The longitudinal Doppler effect is also studied.

While I look for an equivalence between this non-empty anisotropic universe, which is difficult to work with, and an empty and isotropic universe where the laws of physics easily apply, I will be brought to suppose a **variation of mass with speed to conserve momentum** in the absence of any outside force. The natural physical interpretation of the well-known relativistic law:

$$\mathbf{m = \frac{mo}{\sqrt{1 - \frac{u^2}{c^2}}}} \qquad \text{or} \qquad \mathbf{m\sqrt{c^2 - u^2} = mo\ c}$$

simply expresses the conservation of momentum.

A new metrics is introduced. It conserves time, which remains an **absolute universal time,** but it doesn't conserve distances: the **dilatation of lengths** observed from a privileged referential that expresses the **expansion of the universe**.

As in relativity, force is not conserved, no more than electric and magnetic fields are. Finally, **Maxwell's equations** are derived as well as their **invariance** by change of galilean referential. This is achieved by allowing the speed of light, electric permittivity and magnetic permeability to change with the referential.

The principal results of special relativity are rederived by a classical reasoning, in a universe where time is universal and where the speed of light loses its invariant character.

CHAPTER I

COSMOLOGY

HYDRODYNAMIC MODEL OF A EUCLIDIAN UNIVERSE – NEWTON'S CONSTANT AND CARACTERISTIC PROPAGATION SPEED

Foreword In a classical mechanics context, we will be looking for autosemblable solutions to the conservation equations of hydrodynamics in the spherical geometry of an expanding universe.

Using a hypothesis on Newton's constant G, I will link the speed of light to the speed of sound in the **supposedly perfect fluid** that the universe itself constitutes.

The special case of a uniform expanding universe will allow us to form galilean referentials where the speed of light at a given point of the universe will be linked to the Lagrangian coordinate through a simple formula, by analogy with the speed of sound, therefore losing its universality.

The calculations are treated in Lagrangian coordinates, the mass of the universe is taken to be a constant, the state equation is the perfect gas equation, Local Thermodynamical Equilibrium (LTE) is achieved. The existence of a universal time and an absolute referential linked to the singular big-bang point are implicitly accepted.

Notations:

(polar and axial vectors are noted in **bold** characters)

r	Eulerian coordinate
x	Lagrangian coordinate
ρ_0	initial density
ρ	density
$\mathbf{u}$	velocity (Eulerian)
p	total pressure
p_m	matter pressure
p_r	radiation pressure
U	gravitational potential
R	universe radius
T	supposed black body temperature
S	specific entropy
e_i	specific internal energy
e_m	specific matter energy
e_r	specific radiation energy
G	Newton's constant
M	universe mass
t	universal time

Conservation equations in a spherical geometry

$$
(1)\quad \begin{cases} \dfrac{r}{x} = \dfrac{\rho 0}{\rho}\left(\dfrac{x}{r}\right)^2 & \text{conservation of mass}^* \\ \rho\,\dfrac{\mathbf{u}}{t} = \mathbf{-grad}\ p + \rho\ \mathbf{grad}U & \text{conservation of impulsion} \\ \dfrac{e\;\;i}{t} = -p\dfrac{1/\;\rho}{t} + T\dfrac{S}{t} & \text{conservation of energy} \end{cases}
$$

Hypothesizes: The density ρ depends only on t

$p_m = nk\rho T$ (perfect gas)

$$e_m = \frac{nk}{\gamma\text{-}1}\ T$$

γ being the polytropic coefficient, k the Boltzman constant and n the number of gas moles

$$p_r = \frac{aT^4}{3}$$

$$e_r = \frac{aT^4}{\rho} \qquad \text{a: radiative constant}$$

we have the following relations :

$$\begin{cases} p = p_m + p_r \\ e_i = e_m + e_r \end{cases}$$

<u>Gravitational potential</u>

For a homogeneous plasma sphere (radius R) [ρ(x,t) = ρ(t)] , we have:

$$(2) \qquad \mathbf{U = 2\pi\ G\ \rho\ (R^2 - \frac{r^2}{3})} \qquad \text{(classical formula)}$$

$r \leq R$ ref./10/

<u>Searching for a particular form of Newton's constant G.</u>

Dimensional analysis tells that we can write G under the following form

$$\mathbf{G = \lambda\ v^2\ \frac{l}{m}}$$

v is a characteristic velocity
l is a characteristic length
m is a characteristic mass
λ is a dimensionless proportionality factor*

---

* At any given time, the differential relation $4\pi\rho r^2 dr = 4\pi\rho_o x^2 dx$ applies

The motion of a test body (mass **m**) acted upon by the gravitational actions of masses $\mathbf{m_1, m_2, \ldots, m_n}$ depends on the universe in which this motion takes place, and therefore it depends a priori on the mass and the geometry of this universe.

This dependence can only express itself in G. From there, one could write:

$l = R$ universe radius $m = M$ universe mass

Universe gravitational potential at a point of spherical coordinate R

$$U^* = G\frac{M}{R} = \left(\lambda v^2 \frac{R}{M}\right)\frac{M}{R} = \lambda\, v^2$$

Keeping in mind the mass-energy equivalence of special relativity we can see that U* must be of the order of c_0^2 , c_0 being the speed of light at the center of the universe (we will eventually see that the speed of light depends on r)

The total energy is in fact the sum of the gravitational energy, the kinetic energy and the internal energy.

In the case of a static universe possessing a negligible internal energy, one can write

$$\lambda = 1 \qquad U^* = c_0^2$$

Let us set λ's value at 1, giving:

$$\mathbf{G = c_0^2\, \frac{R(t)}{M}}$$

This is done to lighten up the equations, but it is not a necessary hypothesis.

NB 1 *As M is taken to be time-independent, G varies like R (if c_0 is time-independent) and therefore increases with time. This is different from Dirac's hypothesis (ref. 23), but only in the special case of a uniform expansion (see page 13).*

NB 2 *As R(0) = 0, G is null at the beginning of time. Could the absence of gravitational forces at that instant have encouraged the "big-bang" itself?*

Let's come back to equation (2). Substituting G by its value $c_0^2\,\frac{R}{M}$ and ρ by $\frac{M}{4/3ðR^3}$,

we obtain:

$$U = 2ð\, c_0^2\,\frac{R}{M}\,\frac{M}{4/3ðR^3}\left(R^2 - \frac{r^2}{3}\right)$$

* At any given time, the differential relation $4\pi\rho r^2 dr = 4\pi\rho_o x^2 dx$ applies

(3) $$U = \frac{3}{2}\ c_0^2 \left(1 - \frac{r^2}{3R^2}\right)$$

Searching for exact solutions to the conservation equations (1)

I will look for particular variable separated solutions (in a spherical geometry) of the following aspect:

(4) $$r = x\ \varphi(t)$$

solutions first studied by Keller, then by Kidder (ref 20 and ref 21).

Initial conditions and boundary conditions:

Let t_0 the initial time (it doesn't have to be null). We have $\varphi(t_0) = 1$, the Lagrangian coordinate therefore being identical to the Eulerian coordinate.

Additionally:

$R = X\varphi(t)$ X being the initial universe radius

Differentiating (4), we get:

$$u = \partial r/\partial t)_x = x\ \varphi'(t)$$

Universe expansion speed at the boundaries

$$u^* = \partial R/\partial t)_x = X\ \varphi'(t)$$

Closure equation and physical interpretation

At any given moment, the universe is bounded by the presence of the initial photons. We will take their speed to be $c_0(t)$:
:

$$u^* = c_0(t) = X\varphi'(t)$$

Note: This yields:

$$\frac{r}{u} = \frac{\varphi(t)}{\varphi'(t)} = \frac{R}{u^*} = \frac{R(t)}{c_0(t)}$$

The gravitational potential can be written (formula (3) page 9):

$$U = \frac{3}{2}\,c_0^2 - \frac{c_0^2}{2}\,\frac{r^2}{R^2} = \frac{3}{2}\,c_0^2 - \frac{c_0^2}{2}\,\frac{u^2}{c_0^2}$$

$$U = \frac{3}{2}\,c_0^2 - \frac{u^2}{2}$$

The kinetic energy per mass unit being $1/2u^2$, the sum of the potential energy and the kinetic energy is then:

$$\mathbf{U + e_c = U + 1/2u^2 = \frac{3}{2}\,c_0^2} \quad \text{therefore time-independent}$$

NB *Equation (2), used in deriving the gravitational potential was established rigorously for a static regime (static masses).*

It is easy to show a posteriori that it satisfies in two special cases the generalized Poisson equation for retarded potentials where the propagation speed of a perturbation would be proportional to c.

$$DU - \frac{1}{c^2}\frac{\partial^2 U}{\partial t^2} = -4ð\ r(t)\ G$$

By noticing that the $(1 - \frac{r^2}{3R^2})$ *term in equation (3) is time-independent, U is proportional to* c^2 *; therefore :* $\frac{2U}{¶\,t^2} = 0$ *if c is constant or if c=cst or* $c\ µ\ t^{1/2}$

I can than check, in spherical coordinates , the expression of $DU = \frac{2}{r}\,\frac{U}{r} + \frac{2U}{c^2 t\ 2} =$

$$-\frac{3c^2}{R^2} = -4ð\ r\ G \quad \text{since} \quad G = \frac{c^2R}{M} = \frac{c^2R}{\frac{4ð}{3}R^3\,r(t)} = \frac{3c^2}{4ðR^2\,r}$$

<u>Solution of system (1)</u>

In monodimensional spherical coordinates, system (1) can be written:

$$\begin{cases} \frac{r}{x} = \frac{\rho_0}{\rho}\left(\frac{x}{r}\right)^2 \\ \rho \frac{u}{t} = -\frac{p}{r} + \rho \frac{U}{r} \\ \frac{e\ \ i}{t} = \frac{p}{\rho^2}\frac{\rho}{t} + T\frac{S}{t} \end{cases}$$

Our hypothesizes say that ρ only depends on t:

$$(5) \quad \begin{cases} \rho = \rho_0 \ \frac{1}{\varphi^3} \\ \rho_0 \ \frac{1}{\varphi^3} \text{ x } \varphi''(t) = -\frac{p}{r} - \rho \ \frac{c_0^2 r}{R^2} \\ \frac{e\ \ i}{t} = \frac{p}{\rho^2}\frac{\rho}{t} + T\frac{S}{t} \end{cases}$$

Let us develop the impulsion equation, this time using r as the variable:

$$\frac{p}{r} = -\rho(t)\left[\frac{\varphi\varphi'' + \varphi'^2}{\varphi^2}\right] r$$ and, by integrating:

$$p = K(t) - \frac{r^2}{2} \ \rho(t) \ F(t) \qquad \text{with} \qquad F = \left[\frac{\varphi\varphi'' + \varphi'^2}{\varphi^2}\right]$$ K being the integration constant

<u>Derivation of K – Closure formula</u>

Let us set an obvious condition:

p=0 for r=R (zero pressure at the universe's boundaries)

therefore: $K = \frac{R^2}{2} \ \rho(t) \ F(t)$

$$p = 1/2\ \rho\ F\ [R^2 - r^2] = \rho\ \frac{FR^2}{2}\left[1 - \frac{r^2}{R^2}\right]$$

finally, knowing that:

$\frac{R}{t} = c_0(t) = X\ \varphi'(t)$ I can say that:

$$p = 1/2\ \rho(t)\ F(t)\ c_0^2\ \frac{\varphi^2}{\varphi'^2}\left(1 - \frac{u^2}{c_0^2}\right)$$

we can rewrite this in the following way if we set:

$$\Psi(t) = \frac{\varphi\varphi''}{\varphi'^2} + 1$$

$$p = 1/2\ \rho(t)\ \Psi(t)\ c_0^2\left(1 - \frac{u^2}{c_0^2}\right)$$

In the next pages you can find the solutions for the general case where $\varphi(t)$ can take any shape, assuming that we are in presence of a matter phase ($p_m >> p_r$, $e_m >> e_r$) or a radiative phase ($p_m << p_r$, $e_m << e_r$). In practice this will amount to choosing between two different values of the polytropic γ coefficient.

$$\begin{cases} \gamma = 5/3 \text{ matter phase (monoatomic plasma)} \\ \gamma = 4/3 \text{ radiation phase} \end{cases}$$

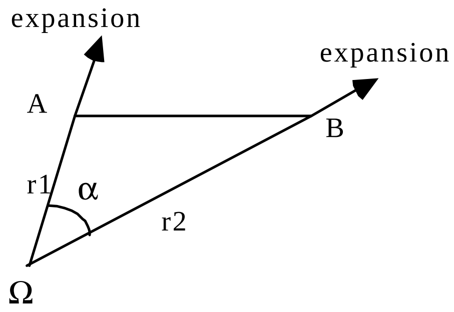
Particular solution $\varphi = t/t_0$. Galilean referentials.

I am now looking for solutions where the universe is expanding at a constant speed. In these solutions I can therefore attach to galilean referentials to two randomly chosen universe points.

Let Ω be the center of this constant expansion speed universe.
Let A and B be two points of this universe.

$$\Omega A = r_1 = x_1 \frac{t}{t_0}$$

$$\Omega B = r_2 = x_2 \frac{t}{t_0}$$



⇒ It is obvious that AB is a linear function of time. I can then assign a galilean referential to each point. Therefore:

$$\varphi(t) = \frac{t}{t_0} \qquad \varphi'(t) = \frac{1}{t_0} \quad \varphi''(t) = 0 \quad \Psi(t) = 1$$

$$r = x \frac{t}{t_0} \qquad\qquad u = \frac{x}{t_0}$$

$$R(t) = X \frac{t}{t_0} \qquad\qquad c = \frac{R}{t} = \frac{X}{t_0}$$

Newton's constant can be written:

$$\mathbf{G = \frac{c_0^2 R}{M} = \frac{c_0^3 t}{M}} \qquad (6)$$

G varies linearly with the universal time t

I can state pressure the following way:

$$p = \frac{1}{2}\, c_0^2\, \rho(t) \left[1 - \frac{x^2}{X^2} \right] = \frac{1}{2}\, c_0^2\, \rho(t) \left[1 - \frac{u^2}{c_0^2} \right]$$

with $\rho = \rho_0 \left(\frac{t_0}{t} \right)^3$

Local speed of sound

Let Γ be the local speed of sound at a given point of the universe. Γ is the speed with which a perturbation moves with respect to the expanding medium in which this perturbation lives:

$$\Gamma = \sqrt{\left.\frac{p}{\rho}\right)_x} = \frac{c_0}{\sqrt{2}}\sqrt{1 - \frac{x^2}{X^2}}$$

$$\Gamma = \frac{c_0}{\sqrt{2}}\sqrt{1 - \frac{u^2}{c_0^2}}$$

At Γ, x = 0, u = 0, the speed of light is c_0 and therefore:

$$\Gamma_0 = \frac{c_0}{\sqrt{2}}$$

By analogy, we will hypothesize that at a given universe point:

$$\Gamma = \frac{c}{\sqrt{2}}$$

c being the local speed of light (Lagrange coordinate)

It follows that time-independent **c** has the following spatial dependence:

$$c(x) = \Gamma = c_0\sqrt{1 - \frac{x^2}{X^2}} = c_0\sqrt{1 - \frac{r^2}{R^2}}$$

$$c = c_0\sqrt{1 - \frac{u^2}{c_0^2}}$$

$$c^2 = c_0^2 - u^2$$

$$\mathbf{c = \sqrt{c_0^2 - u^2}} \qquad (7)$$

NB- *It wouldn't be wise to use this analogy for mediums with infinite opacity, since sound propagates in these mediums whereas light doesn't. The considered mediums being almost totally transparent (at least this would be the case after a certain universal time t), we don't have to worry about this. On the other hand, this analogy doesn't work in absolute vacuum (a case I exclude here) since light propagates in that medium whereas sound doesn't. Þ This a purely formal analogy.*

<u>Energy equation. Boltzmann's constant k and radiation constant a</u>

Two cases have to be considered:

1) the so-called <u>"matter" phase</u> (where $p_m >> p_r$ and $e_m >> e_r$)
The formula derived for pressure shows that the kT product is time-independent. If k is time independent, then the temperature would also be time independent, a physically unrealistic solution. Therefore one must assign a time-dependence to k, which would change as $\frac{1}{T}$.

It follows that: $\frac{e\ m}{t} = \frac{e\ i}{t} = 0$

It follows form solving the energy equation that:

$$\frac{S}{t} \sim \frac{k(t)}{t} \sim \frac{1}{Tt}$$

2) the so-called <u>"radiation" phase</u> (where $p_m << p_r$ and $e_m << e_r$)

$$e_r = \frac{aT^4}{\rho} \qquad \text{et} \qquad p_r = \frac{aT^4}{3} \qquad e_r = 3\,\frac{p_r}{\rho}$$

$\frac{p_r}{\rho}$ being time-independent, we find: : $\frac{e\ r}{t} = \frac{e\ i}{t} = 0$
All the different specific energies:

-gravitational $\quad e_g = U = \frac{3}{2}\ c_0^2 - \frac{u^2}{2}$

-kinetic $\quad e_c = 1/2\ u^2$

-internal $\quad e_i = (\gamma - 1)\,\frac{p}{\rho}$ (matter or radiation)

are time-independent.

For the matter phase $\quad \gamma = 5/3 \quad$ (monoatomic gas)

and for the radiation phase $\quad \gamma = 4/3 \quad$ (polytropic coefficient for radiation in vacuum)

Let's come back to the radiation phase. The $a\ T^4/\rho$ term is time-independent. The radiation constant "a" varies as ρ/T^4. The temporal variability hypothesis on the "a" constant is not mandatory. If we assume that "a" is a universal and invariable constant, solving for the energy shows us that T^4 varies like ρ. T varies like $t^{-3/4}$ and entropy S like $t^{3/4}$ and therefore like $\frac{1}{T}$.

⇒ Entropy increases with time and like $\frac{1}{T}$ as expected.

Free energy A and Thermodynamic Potential Φ

We have: $A = e_r - TS$

and $\Phi = e_r - TS + p/\rho$

⇒ A and Φ are also time-independent thermodynamical quantities.

Let's go back to the matter phase. If we want to keep this property that was established for the radiation phase, S must vary as $\frac{1}{T}$ and since $\frac{S}{t} \sim \frac{1}{Tt}$

T varies as $\frac{1}{t}$ and k is proportional to time.

NB Numerical values

If we take t to be 15 10^9 years (the estimated age of the universe) and T ≈ 2,7°K, we can check that $p_r >> p_m$ and $e_r >> e_m$ by several orders of magnitude because of ρ's small numerical value ($\rho < 10^{-29}$ CGS). My radiation phase hypothesis is therefore legitimate, at least for times after a certain time t.

Physical interpretation

I have brought to evidence a uniformly expanding (with respect to the absolute referential) universe with a spherical geometry that satisfies, in rational classical mechanics, the hydrodynamic conservation equations if some hypothesizes regarding the variability of various basic constants (G, k, a,…) are made.

These solutions correspond to uniform densities, but the pressures, and therefore the temperatures, are time-dependant as well as a space-dependant. This gives us a space-dependant sonic speed. By reasoning with an analogy, I showed that this sonic speed (longitudinal waves) could be made formally identical to the speed of light (transversal waves) by the introduction of a numerical constant $\sqrt{2}$. All this is done in view of well-defined theoretical limits.

Speed of light in the absolute referential R

In rational mechanics, velocities add algebraically and the speed of light at a given point m is written

(8) $c_a = u + \sqrt{c_0^2 - u^2}$ if the expansion direction and the light radiation direction are identical

(8) another expression:

$$c_a = c_0\left[\frac{u}{c_0} + \sqrt{1 - \frac{u^2}{c_0^2}}\right] = c_0\ [\ \mu + \sqrt{1 - \mu^2}]$$

with $\mu = u/c_0$ μ ranging from 0 to 1 when moving from the center to the boundary

Variation of c_a as a function of μ

c_a is worth c_0 in the center, has a maximum $\sqrt{2}\ c_0$ when $u = c_0\sqrt{2}$, then decreases to c_0 for $u = c_0$ (periphery) $\Rightarrow$ $\mathbf{c_a}$ is of the same order of magnitude as $\mathbf{c_o}$

Numerical values in the general case

I will limit myself to the case where:

$$\varphi(t) = \left(\frac{t}{t_0}\right)^{\lambda}$$

we have: $\Psi(t) = \dfrac{\varphi\varphi''}{\varphi'^2} + 1 = \dfrac{2\lambda - 1}{\lambda} = \text{cste}$

Time-variation of the main quantities

I assume that the matter internal energy is negligible with respect to the radiation internal energy (we are in the so-called radiation phase). It is easily shown that:

universe radius	$R(t)\ \#\ t^{\lambda}$
speed	$u(t)\ \#\ t^{\lambda-1}$
density	$\rho(t)\ \#\ t^{-3\lambda}$
pressure	$p(t)\ \#\ t^{-\lambda-2}$
temperature	$T(t)\ \#\ t^{\frac{-\lambda-2}{4}}$
Newton's "constant"	$G(t)\ \#\ t^{3\lambda-2}$
internal energy	$ei(t)\ \#\ t^{2\lambda-2}$
entropy	$S(t)\ \#\ t^{\frac{9\lambda}{4} - \frac{3}{2}}$

Here is a table that shows the evolution of these quantities as a function of λ.

The cases where $\lambda < \frac{2}{3}$ are physically unacceptable since they would imply a decrease of entropy with time.

The λ = 2/3 case is interesting since implies that G and entropy are time-independent.

λ	1/2	2/3	3/4	1	2
R(t)	$t^{1/2}$	$t^{2/3}$	$t^{3/4}$	t	t^{2}
$c_0(t)$	$t^{-1/2}$	$t^{-1/3}$	$t^{-1/4}$	cst	t
$\rho(t)$	$t^{-3/2}$	t^{-2}	$t^{-9/4}$	t^{-3}	t^{-6}
p(t)	$t^{-5/2}$	$t^{-8/3}$	$t^{-11/4}$	t^{-3}	t^{-4}
T(t)	$t^{-5/8}$	$t^{-2/3}$#1/R	$t^{-11/8}$	$t^{-3/4}$	t^{-1}
G(t)	$t^{-1/2}$	cst	$t^{1/4}$	t	t^{4}
$e_i(t)$	t^{-1}	$t^{-2/3}$#1/R	$t^{-1/2}$	cst	t^{2}
S(t)	$t^{-3/8}$	cst	$t^{3/16}$	$t^{3/4}$#1/T	t^{3}

Naturally, the quantities p(t) T(t) $e_i(t)$ and S(t) are also space-dependant.
I can write the speed of light in Lagrangian coordinates under this form:

$c_0(t)\sqrt{1 - \frac{u^2}{c_0^2}}$ where $\frac{u^2}{c_0^2}$ is only space-dependant. Therefore I can rewrite this

$c_{00}\left(\frac{t}{t_0}\right)^{\lambda-1}\sqrt{1 - \frac{x^2}{X^2}}$ or $c_{00}\left(\frac{t}{t_0}\right)^{\lambda-1}\sqrt{1 - \frac{r^2}{R^2}}$

$\Rightarrow$ In the general case, the speed of light is space-dependant (r coordinate in Eulerian and x coordinate in Lagrangian) and time-dependant.

CHAPTER II

TRANSFORMATION OF THE LAWS OF MECHANICS

GRAVITATIONAL ENERGY AND MASS-ENERGY EQUIVALENCE – SPEED OF LIGHT AND LIMIT SPEED - DOPPLER EFFECT

Introduction

Newton's second law: $\mathbf{F} = m\gamma$ implicitly assumes:

1) nonvariability of mass
2) a validity domain for the law in an infinite and empty universe (void of any masses)

I will keep the first condition. But in the light of chapter 1, I can't keep the second. Let us add a third one

3) the photon has a mass, a function of its frequency as special relativity tells us:

$$m = h\,\nu/c^2 \qquad \text{(h: Planck's constant)}$$

This last proposition, independent from any physical theory, comes from experimental data. This was observed and studied as early as the XVIII century and validated by Eddington's experiments destined to test general relativity during the solar eclipse of 1919.

⇒ a photon is deviated by a gravitational field, therefore it has a mass by definition.

⇒ **The point of this study is to establish a Newton's law modified by the universe in which it is applied.**

Modification of Newton' law

Let m be a point test-mass. The force **F** applied on it can be split up into three components:

f the classical mechanics force that would exist in an infinite and empty universe.

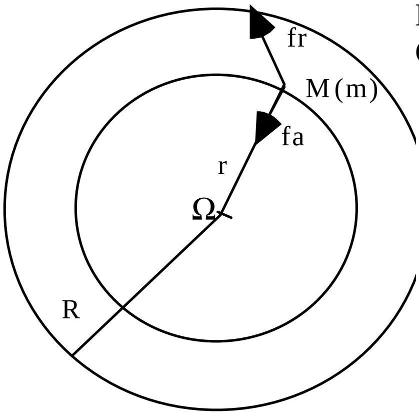
$\mathbf{f_a}$ the gravitational attraction force directed towards the center Ω and caused by the mass of universe between a given point M and Ω.

$\mathbf{f_r}$ the repulsive or attractive force directed towards the periphery and caused by the pressure due to the expansion of the universe.

Valuation of $\mathbf{f_a}$

$$\Omega M = r \qquad \text{(Eulerian coordinate)}$$

The mass of universe between Ω and M is $\frac{4}{3}\,ð\,\rho(t)\,r^3$



By applying Newton's universal attraction law and the Gauss theorem, we have:

$$\mathbf{f_a} = -\,G\,(4/3\;ð\;\rho\;r^3)\;\frac{\Omega M}{r^3}\;m$$

and according to (6) page 13:

$$G = c_0^2\;R/M$$

$$G = \frac{3c_0}{4ð\;\rho\;R^2}$$

$$\mathbf{f_a} = -\,c_0^2\,\frac{1}{R^2}\;\mathbf{\Omega M}\;\;m$$

But we are in a uniformly expanding universe, therefore:

$$R = c_0\,t \qquad t \text{ being universal time}$$

$$\mathbf{f_a} = -\frac{m}{t^2}\;\mathbf{\Omega M}$$

Valuation of $\mathbf{f_r}$

The universe's expansion speed at M is:

$$\mathbf{u} = \frac{\mathbf{\Omega M}}{t}$$

The test mass m being driven by the forces of the universe's pressure, it can be considered as being acted upon by a force $\mathbf{f_r}$:

$$\mathbf{f_r} = m\,\frac{d\mathbf{u}}{dt} \quad *$$

$\frac{du}{dt}$ being the driving acceleration.

* In the general case where M's trajectory is not a straight line going through Ω , $\mathbf{f_r}$ is not a central force.

$$\mathbf{f_r} = m\,\frac{d\mathbf{\Omega M}/t}{dt} = m\left[\frac{1}{t}\,\frac{d\mathbf{\Omega M}}{dt} - \frac{\mathbf{\Omega M}}{t^2}\right]$$

F then takes the form:

$$\mathbf{F} = \mathbf{f} - \frac{m}{t^2}\,\mathbf{\Omega M} + \frac{m}{t}\,\frac{d\mathbf{\Omega M}}{dt} - m\,\frac{\mathbf{\Omega M}}{t^2}$$

Special case f = 0

In the absence of any force other than forces caused by the presence of an expanding universe, we have:

$$\mathbf{F} = -2\,\frac{m}{t^2}\,\mathbf{\Omega M} + \frac{m}{t}\,\frac{d\mathbf{\Omega M}}{dt}$$

and by applying Newton's law: $\mathbf{F} = m\,\frac{d^2\mathbf{\Omega M}}{dt^2}$

we get:

$$\frac{d^2\mathbf{\Omega M}}{dt^2} - \frac{1}{t}\,\frac{d\mathbf{\Omega M}}{dt} + \frac{2}{t^2}\,\mathbf{\Omega M} = 0 \qquad (2)$$

In classical rational mechanics, we had a simpler formula:

$$\frac{d^2\mathbf{\Omega M}}{dt^2} = 0 \qquad (2')$$

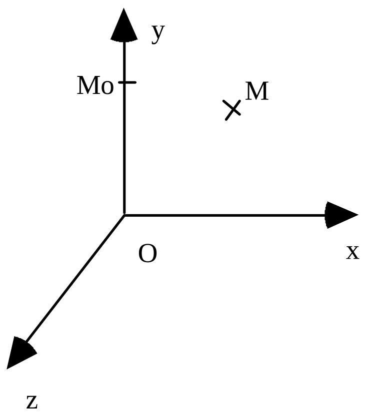
NB: *Note the invariance of (2) when t is changed to –t*

Introducing an expanding universe into Newton's equation (2') complicates the equation by adding two extra terms but doesn't fundamentally change the following characteristic:

⇒ Equation (2), like equation (2'), is absolutely <u>independent</u> of the uniformly expanding universe considered.
The mass of the universe M, its radius R and the speed of light c_0 don't affect the equation.
The motion of M depends only on the universal time t and the initial speed and position conditions.

<u>First integral – Solution of equation (2)</u>

<u>New notations.</u>



Let us consider the absolute referential Ra, with cartesian axes :

Ox, Oy, Oz.

At the initial instant t_0 , the object's position is M_0 (on Oy) and its absolute speed is v_0

Instantaneous relative speed

At any moment the speed $\mathbf{v} = \frac{d\mathbf{OM}}{dt}$ can be considered as the sum of the driving speed $\mathbf{u} = \frac{\mathbf{OM}}{t}$ and an instantaneous relative speed **w** that describes M's speed.

(NB- In the general case, during its movement through space M changes galilean referentials in a continuous manner)

Therefore:

$$\mathbf{v} = \frac{d\mathbf{M}}{dt} = \mathbf{u}+\mathbf{w}= \frac{\mathbf{OM}}{t} + \mathbf{w} \qquad (3)$$

$$\frac{d^2\mathbf{M}}{dt^2} - \frac{1}{t}\frac{d\mathbf{M}}{dt} + \frac{2}{t^2}\mathbf{OM} = 0 \qquad (2)$$

It is then easily shown that:

$$\mathbf{u\,du + w\,dw = 0}$$

$$\mathbf{u^2 + w^2 = cst = u_0{}^2 + w_0{}^2} \qquad (4)$$

(4) constitutes a first integral of (2)

NB- Let M1 and M2 be two points of universe. The difference between their gravitational potentials is:

$$U_2 - U_1 = \frac{3}{2}\,c_0^2 - \frac{u_2^2}{2} - \frac{3}{2}\,c_0^2 + \frac{u_1^2}{2} = \frac{1}{2}\,u_1^2 - \frac{1}{2}\,u_2^2$$

and according to (4): $U_2 - U_1 = \frac{1}{2}\,w_2^2 - \frac{1}{2}\,w_1^2$

Þ *the potential difference is equal to the kinetic energy variation of a mass M in the local galilean referentials linked to M1 and M2*

Special case of the photon

Let us consider a photon originated from the center of symmetry O. The photon moves with initial speed c_0 by definition. Therefore:

$$u^2 + w^2 = 0 + c_0^2$$

$$w^2 = c_0^2 - u^2 \qquad (5) \qquad \text{formula established on page 15}$$

$$\mathbf{c^2 = c_0^2 - u^2}$$

Complete solution of equation (2)

First of all note that in the general case, motion is not centrally accelerated because of the $\frac{d\mathbf{u}}{dt}$ term.
I will show that M's trajectory is planar. The specific angular momentum **k** can be written:

$$\mathbf{k} = \mathbf{OM} \times \mathbf{v}$$

By differentiating : $\frac{d\mathbf{k}}{dt} = \mathbf{v} \times \mathbf{v} + \mathbf{OM} \times \frac{d\mathbf{v}}{dt}$

$$= \mathbf{OM} \times \frac{d\mathbf{v}}{dt} = \mathbf{OM} \times \frac{\mathbf{v}}{t} = \frac{\mathbf{k}}{t}$$

The solution of the vector equation: $\frac{d\mathbf{k}}{dt} - \frac{\mathbf{k}}{t} = 0$

is: $\mathbf{k} = t\,\mathbf{C}$ **C** being a constant vector,
which proves the proposition, **k** being perpendicular to the motion plane.

I can then get rid of the 3rd coordinate z. The trajectory is completely described by separating equation (2) on the Ox and Oy axes:

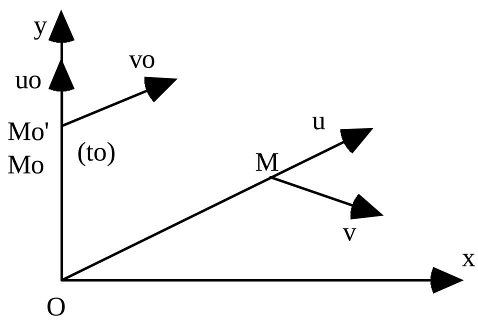
$$\begin{cases} \dfrac{d^2x}{dt^2} - \dfrac{1}{t}\dfrac{dx}{dt} + \dfrac{2}{t^2}\, x = 0 \\ \dfrac{d^2y}{dt^2} - \dfrac{1}{t}\dfrac{dy}{dt} + \dfrac{2}{t^2}\, y = 0 \end{cases} \qquad (2')$$

The exact solutions of theses two equations are:

$$\begin{cases} x = t\left[A\cos\left(\mathrm{Log}\dfrac{t}{t_0}\right) + B\sin\left(\mathrm{Log}\dfrac{t}{t_0}\right)\right] \\ y = t\left[C\cos\left(\mathrm{Log}\dfrac{t}{t_0}\right) + D\sin\left(\mathrm{Log}\dfrac{t}{t_0}\right)\right] \end{cases}$$

A, B, C, D being constants depending on the initial conditions.

To simplify the equation, let me set:



$$\varphi = \mathrm{Log}\frac{t}{t_0} \quad \text{or} \quad t = t_0\, e^{\varphi} \quad d\varphi = \frac{dt}{t}$$

$$\begin{cases} x = t_0\, e^{\varphi}\,(A\cos\varphi + B\sin\varphi) \\ y = t_0\, e^{\varphi}\,(C\cos\varphi + D\sin\varphi) \end{cases}$$

Trajectory

By setting: $X = \dfrac{x}{t} \quad Y = \dfrac{y}{t}$,

we get

$$\begin{cases} X = A\cos\varphi + B\sin\varphi \\ Y = C\cos\varphi + D\sin\varphi \end{cases}$$

In the moving referential OX, OY linked to the expansion of the universe and determined by the point of universe M'_0 identical to M_0 at time t_0, the trajectory is an <u>ellipse</u> centered in O (O is NOT the focus of the ellipse).
In the absolute referential Ox, Oy this trajectory looks like a kind of elliptic spiral.
Furthermore, in the moving referential OX, OY, the motion is periodical (period T):

$$T = t_0\,(e^{2ð} - 1)$$

Special cases

1) Circular trajectory

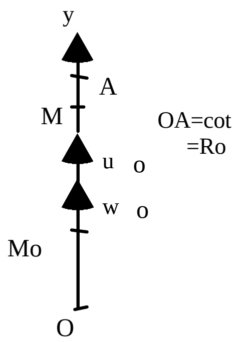
In the moving referential OX, OY, the trajectories are circles if and only if:

$$\mathbf{w_0} \perp \mathbf{u_0} \qquad \text{and} \qquad |\mathbf{w_0}| = |\mathbf{u_0}|$$

2) Rectilinear trajectory

Such trajectories are exceptional. In general, trajectories are curved and in a certain way the universe is curved. However if **w_0** is collinear to **u_0**, the trajectory is rectilinear. The equation of motion comes down to:

$$y = t\,[\, u_0\cos\varphi + w_0\sin\varphi \,]$$



It is easily shown that M stays inside the sphere of universe whose radius is:

$$OA = R_0 = c_0\, t$$

if and only if:

$$w_0 = \sqrt{c_0^2 - u_0^2}$$

The case where $w_0 = \sqrt{c_0^2 - u_0^2}$ corresponds to the photon. The **photon**'s speed, or speed of light, then appears as a "**limit**" speed, null at the boundary (u_0=c_0).

Beyond that limit M could be outside of the universe sphere which, by definition, is impossible.

From a certain point of view, we can consider the speed of light in vacuum to be a universal constant, but this is never physically achieved since at any point of space one can define a nonzero mass density, which I take to be uniform in my hypothesizes.

Physically, one could suppose that the universe radius $R_0 = c_0t$ is determined by the initial photons emitted during the "big-bang".

And I have just proved that any other photon emission occurring at any other time at any point of space doesn't question this physical limit R_0.

Note: In the case of a photon emitted at A such as $OA = c_0t$ (universe radius) and $w_0 = 0$, the equation of motion is:

$$y = c_0\, t \cos\left[\mathrm{Log}\frac{t}{t_0}\right]$$

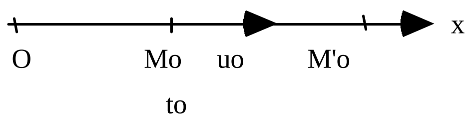
This photon, although being emitted with zero relative speed, moves along the Oy axis. The time taken to reach O is:

$$t_1 = t_0\, e^{\eth/2}$$

Doppler effect

To simplify the calculations, I will stick to the following special case:

* longitudinal Doppler effect (monodimensional setup)
* fixed observation point, necessarily O itself.



The mobile Mo is a point of universe moving with speed u_0 on the Ox axis and emitting light signals of period T.
At time t_0, Mo emits a light signal towards O which, according to what I wrote above, moves with the following relative speed at Mo: $w_0 = \sqrt{c_0^2 - u_0^2}$. Its absolute speed v_0 is:

$$v_0 = u_0 - \sqrt{c_0^2 - u_0^2}$$

The photon's equation of motion is:

$$x = t \left[u_0 \cos \mathrm{Log}\frac{t}{t_0} - wo \sin \mathrm{Log}\frac{t}{t_0} \right]$$

The photon reaches O at time t_1 such as:

$$\varphi = \mathrm{Log}\frac{t}{t_0} \qquad \mathrm{tg}\varphi_1 = \frac{u_0}{w_0} \quad \text{ou} \quad \sin\varphi_1 = \frac{u_0}{c_0}$$

At time $t'_o = t_o + T$ the mobile is located at M'_o and emits a second signal. This second photon is described by the following formula:

$$\varphi' = \mathrm{Log}\frac{t}{t'_0}$$

$$x = t\,[u_0 \cos\varphi' - w_0 \sin\varphi']$$

It reaches O at time $t'_1 = t_1 + T'$ such as: $\sin\varphi'_1 = \dfrac{u_0}{c_0} = \sin\varphi_1$

therefore: $\varphi_1' = \varphi_1$ and so : $\mathrm{Log}\dfrac{t_1 + T'}{t'_0} = \mathrm{Log}\dfrac{t_1}{t_0}$

$$\frac{t_1 + T'}{t_0 + T} = \frac{t_1}{t_0} = \frac{T'}{T}$$

T', the period of a light signal received in O and emitted by a mobile moving with constant speed u_0 (and emitting a light signal with period T) is:

$$\mathbf{T' = T\, e^{\mathrm{Arc\,sin}\, u_0/c_0}}$$

<u>Comparison with the "classical" and relativistic (special relativity) Doppler formula</u>

In the case of the longitudinal Doppler effect, I set: $y = \dfrac{T'}{T}$ and $x = \dfrac{u_0}{c_0}$

The observer is assumed to stand still at O and the source S is <u>moving away</u> from O at a constant speed u_0 :

1) Classical theory: $y_1 = 1 + x$

2) Special relativity: $y_2 = \sqrt{\dfrac{1 + x}{1 - x}}$

3) Present theory: $y_3 = e^{\mathrm{Arc\,sin}x}$

By expanding y_2 and y_3 to the third order, we get:

$$y_2 = 1 + x + \frac{x^2}{2} + \frac{x^3}{2}$$

$$y_3 = 1 + x + \frac{x^2}{2} + \frac{x^3}{3}$$

At the first order, all models are equivalent.
At the second order, models 2 and 3 are equivalent.
At the third order, models 2 and 3 are very close (a 0.5 factor versus a 0.33 factor for the x^3 term)

If we <u>rigorously</u> establish numerical values for the three functions with x taking different values, including x = 1, we can draw the following table:

x	0	0,01	0,1	0,3	0,6	0,9	0,99	1
y_1	1	1,01	1,10	1,30	1,6	1,9	1,99	2
y_2	1	1,01	1,105	1,36	2,0	4,36	14,1	infinite
y_3	1	1,01	1,105	1,356	1,9	3,06	4,17	4,81

We can notice that except for values of x close to 1, my model gives results very close to those of special relativity. It is also important to notice that, contrarily to special relativity, y_3 stays finite for x = 1

There is no light cone in this case: any point of the universe is virtually observable from any other point of the universe.

CHAPTER III

COSMOPHYSICS

MAXWELL'S EQUATIONS AND UNIVERSAL TIME

Reminders and Objectives

In the preceding chapters we derived the equations that describe mechanical phenomenon on the cosmological scale, with an absolute space using Cartesian coordinates and whose center is located at the singular point of the "big-bang", a universal time starting with the "big-bang" and a nonvoid universe where the speed of light is spatially-dependant.
These equations are difficult to use on a local scale. This is essentially due to the inhomogeneous nature of the universe, notably the presence of a center of spherical symmetry.
I will now try to define a new kind of physics that can be used in an "ideal" universe, meaning that it is perfectly homogeneous, isotropic and empty (no mass present).
I will limit myself to the case this universe is uniformly expanding, which allows me to introduce galilean referentials in a natural way.

I showed that Newton's constant G could be written the following way:

$$\mathbf{G = c^2 \frac{R}{M}}$$

c being the speed of light at the center and the expansion speed at the boundary of the universe (*this speed was written c_0 in chapters I and II).*

$$\mathbf{R = c\ t} \qquad \text{universe radius}$$

Note that in a rigorously empty universe the speed of light would effectively be a universal constant (special relativity).

Real mass and apparent mass

By reasoning with the example of the photon described in chapter I, we saw that its intrinsic speed, meaning the speed at which it moves with respect to the fluid in which it propagates, varies from c in the center to $\sqrt{c^2 - u^2}$, u being the expansion speed of the universe point considered.

NB: To simplify things we shall suppose the propagation to be rectilinear, along an axis going through the origin (Ox for example).

I want to conserve Newton's second law in the absence of any outside force:

$$\mathbf{F} = 0 = \frac{dm\mathbf{v}}{dt}$$

Here, $\frac{dmv}{dt} = 0$ $\quad$ mv = constant

We have to let mass vary as a function of speed. Let mo be the mass at the center (not the rest mass) and the mass at a given universe point.

We have:

$$mo\ c = m \sqrt{c^2 - u^2}$$

therefore: $$\mathbf{m = \frac{mo\ c}{\sqrt{c^2 - u^2}}}$$

or: $$\mathbf{m = \frac{mo}{\sqrt{1 - u^2/c^2}}}$$

This is the well-known special relativity formula, which was first established experimentally by Kaufmann's work on electrons in the very beginning of the 20^{th} century.

Defining a new metrics

Let's go back to our ideal empty universe. We must conserve mass variation and momentum. Let me consider the following transformation:

$$\mathbf{x = \frac{\sqrt{c^2 - u^2}}{c}\ x' + u\ t}$$
$$\mathbf{y = y'}$$
$$\mathbf{z = z'}$$
$$\mathbf{t = t'} \qquad \text{(universal time)}$$

for two galilean systems (S) and (S') going through rectilinear and uniform translation with respect to each other (Ox axis).

This transformation is halfway between Galileo's and Lorentz's. Note that if time is conserved by definition, lengths are not.
Contraction of distances **in (S') as seen from (S)** is the same as in special relativity.
By setting:

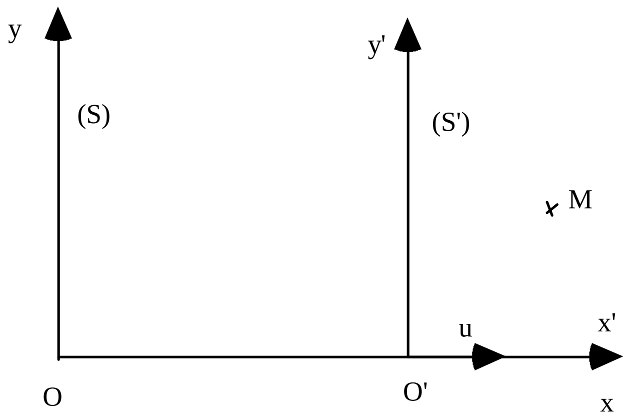
$$v = \frac{dx}{dt} \qquad v' = \frac{dx'}{dt} \qquad \text{we get:}$$

$$v = \frac{\sqrt{c^2 - u^2}}{c}\ v' + u \qquad (3)$$

For a photon v = c and v' = c', therefore:

$$\mathbf{c' = c\sqrt{(c-u)/(c+u)}}$$

Force Transformation



I will limit my use of transformations to the special case where the considered material point M is **at rest** in (S') at time t.

We have: $\mathbf{F} = \frac{dm\mathbf{v}}{dt}$ $\mathbf{F'} = \frac{dm'\mathbf{v'}}{dt}$

with: $m = \frac{mo}{\sqrt{1 - \frac{v^2}{c^2}}}$ $m' = \frac{m'o}{\sqrt{1 - \frac{v'^2}{c'^2}}}$

and: $m'_O = \frac{m_0}{\sqrt{1 - \frac{u^2}{c^2}}}$

c being the speed of light in (S) and c' the speed of light in (S').

By developing:

$\mathbf{F} = m\frac{d\mathbf{v}}{dt} + \mathbf{v}\frac{dm}{dt}$ and projecting on the axes:

$$F_X = \frac{mo}{\sqrt{1 - \frac{v^2}{c^2}}}\frac{dv_X}{dt} + v_X\, mo\,\frac{v}{c^2}\frac{dv}{dt}\left(1 - \frac{v^2}{c^2}\right)^{-3/2}$$

$$\begin{cases} v_x = \dfrac{\sqrt{c^2 - u^2}}{c} v'_x + u \\ v_y = v'_y \\ v_z = v'_z \end{cases}$$

at time t: $v_x = u = v$

by setting: $\gamma_x = \dfrac{dv_x}{dt}$ and $\alpha = \sqrt{1-u^2/c^2}$ we get:

$$F_x = mo \frac{\gamma_x}{\alpha^3}$$

Likewise:

$$F'_x = \frac{m'o}{\sqrt{1 - \dfrac{v'^2}{c'^2}}} \frac{dv'_x}{dt} + v'_x \frac{dm'}{dt}$$

but: $v' = v'_x = 0$ at time t

therefore: $F'_x = m'o \dfrac{dv'_x}{dt} = m'o\ \gamma'_x$

but: $v_x = \alpha\ v'_x + u$ brings on:

$\gamma_x = \alpha\ \gamma_x'$

$F_x' = m'o \dfrac{\gamma_x}{\alpha} = \dfrac{mo}{\alpha^2} \gamma_x$

$$\Longrightarrow \mathbf{F'_x = \alpha\ F_x}$$

Likewise:

$$F_y = \frac{mo}{\sqrt{1 - \dfrac{v^2}{c^2}}} \frac{dv_y}{dt} + v_y \frac{dm}{dt}$$

but at time t, $v' = 0$ $v = v_x = u$ and $v_y = 0$

$$F_y = \frac{m_o}{\alpha}\,\gamma_y$$

$$F'_y = \frac{m'_o}{\sqrt{1 - \frac{v'^2}{c'^2}}}\frac{dv'_y}{dt} + v'_x\frac{dm'}{dt} = m'_o\,\gamma_y$$

$$F'_y = \frac{m_o}{\alpha}\,\gamma_y \qquad ===> \quad \mathbf{F'_y = F_y}$$

and using an analogous proof:

$$===> \quad \mathbf{F'_z = F_z}$$

Important Note:

I am trying to prove that the introduction of a **relative** time is in no way mandatory. Of course the option chosen in special relativity where the speed of light is taken as a universal constant is a valid option.
I will now derive Maxwell's equations and prove their invariance with respect to a change in galilean referentials.

APPLICATION TO ELECTROMAGNETICS: MAXWELL'S EQUATIONS

I will apply transformation (T) to electromagnetics with the following classical hypothesizes:

1) Charge distribution fixed with respect to (S').

2) Validity of the Lorentz force law for an electric charge at rest in (S').

$$\mathbf{F} = q\,(\,\mathbf{E} + \mathbf{u} \times \mathbf{B}\,)$$

E: electric field
B: magnetic field

3) Invariance of electric charge q.

4) Validity of the laws of electrostatics and magnetostatics in (S').

$$\mathrm{div}\,\mathbf{B'} = 0 \qquad \mathbf{rot\ B' = 0}$$

$$\mathrm{div}\,\mathbf{E'} = \rho'/k'_e \qquad \mathbf{rot\ E' = 0}$$

ρ' is the electric density in (S') and k'_e is the electric permittivity in (S') a priori different of the permittivity k_e in (S)

I will show that with these assumptions made, Maxwell's equations are verified in (S). The derivation process used will be identical to that of special relativity.

Furthermore considerations on the cosmological and mechanical order (see preceding pages) will allow me to prove that the components of the force transform in the following way:

$$\begin{cases} F'_x = \alpha F_x \\ F'_y = F_y \\ F'_z = F_z \end{cases}$$

3. <u>Maxwell's equations. Proof</u>

Transformation of the electric field

From Lorentz's formula, we get:

$$(3) \qquad \begin{cases} \mathring{A}'_x = \mathring{A}_x \\ \mathring{A}'_y = \mathring{A}_y - u\,\hat{A}_z \\ \mathring{A}'_z = \mathring{A}_z + u\hat{A}_y \end{cases}$$

Transformation of the magnetic field

Let me apply the following transformation: (cf. the Biot-Savart law and the corresponding special relativity transformation)

$$(4) \qquad \begin{cases} B'_x = \lambda B_x \\ B'_y = \dfrac{\lambda}{\alpha}\left(B_y + \dfrac{u}{c^2} E_z\right) \\ B'_z = \dfrac{\lambda}{\alpha}\left(B_z - \dfrac{u}{c^2} E_y\right) \end{cases} \qquad \text{where } \lambda \text{ is an arbitrary constant}$$

A shall be any vector . The formulas for transforming the coordinates :

$$\begin{cases} x = \alpha\, x' + u\, t \\ y = y' \\ z = z' \end{cases}$$

allow us to evaluate the overall differential **dA** , to set the following relationships :

$$\frac{\partial \mathbf{A}}{\partial x'} = \alpha \frac{\partial \mathbf{A}}{\partial x} \qquad \frac{\partial \mathbf{A}}{\partial y'} = \frac{\partial \mathbf{A}}{\partial y} \qquad \frac{\partial \mathbf{A}}{\partial z'} = \frac{\partial \mathbf{A}}{\partial z}$$

et :

$$\left.\frac{\partial \mathbf{A}}{\partial t}\right)_{S'} = \left.\frac{\partial \mathbf{A}}{\partial t}\right)_{S} + u \frac{\partial \mathbf{A}}{\partial x}$$

The charge distribution is fixed in (S'). The fields are therefore static and I can write:

$$\left.\frac{\mathbf{A}}{t}\right)_{S'} = 0$$ where **A** can be **E** or **B**

3.1 <u>Gauss's theorem applied to the magnetic field</u>

$$\operatorname{div} \mathbf{B'})_{S'} = 0 \qquad \frac{B'\ x}{x'} + \frac{B'\ y}{y'} + \frac{B'\ z}{z'} = 0$$

therefore:

$$\frac{E\ z}{y} - \frac{E\ y}{z} = - \frac{B\ x}{t}\left(\frac{1 - \alpha^2}{u^2}\right) c^2 - \frac{c^2}{u} \operatorname{div} \mathbf{B}$$

knowing that $\alpha^2 = 1 - \frac{u^2}{c^2}$:

$$(5) \qquad \frac{E\ z}{y} - \frac{E\ y}{z} = - \frac{B\ x}{t} - c^2 \frac{\operatorname{div}\mathbf{B}}{u}$$

Furthermore **rot E' = 0** (by assumption) brings:

$$\frac{E'\ z}{E'\ y} - \frac{E'\ y}{z'} = 0$$ and , substituting:

$$(5') \qquad \frac{E\ z}{y} - \frac{E\ y}{z} = - u(\operatorname{div}\mathbf{B} - \frac{B\ x}{x}) = - \frac{B}{t} - u \operatorname{div}\mathbf{B}$$

By comparing (5) and (5'), we get:

$$- c^2 \frac{\operatorname{div}\mathbf{B}}{u} = - u \operatorname{div}\mathbf{B}$$ and, u being different from c:

div **B = 0** [Gauss's theorem in (S)]

knowing this and according to (5):

(6') $$\frac{E_z}{y} - \frac{E_y}{z} = -\frac{B_x}{t}$$

Likewise $\frac{E'_x}{z'} - \frac{E'_z}{x'} = 0$ brings

(6'') $$\frac{E_x}{z} - \frac{E_z}{x} = -\frac{B_y}{t}$$

In the same manner, we get:

(6''') $$\frac{E_y}{x} - \frac{E_x}{y} = -\frac{B_z}{t}$$ from where:

(6) $$\mathbf{rot\ E = -}\frac{\mathbf{B}}{t}$$ [Maxwell-Faraday equation in (S)]

3.2 <u>Gauss's theorem applied to the electric field</u>

$$\text{div } \mathbf{E'})_{S'} = \frac{\rho'}{k'_e}$$

Conservation of charge implies:
q = ρ dx dy dz = ρ' dx' dy' dz'

$\Rightarrow$ $\rho' = \alpha\,\rho$

$$\text{div } \mathbf{E'})_{S'} = \frac{\rho'}{k'_e} = \alpha \text{ div } \mathbf{E'})_{S'} = \frac{\rho'}{k'_e} = \alpha\frac{\rho}{k'_e} = \frac{E'_x}{x'} + \frac{E'_y}{y'} + \frac{E'_z}{z'}$$ therefore:

$$\frac{E_x}{x}(\alpha^2 - 1) + \text{div } \mathbf{E} - u\left(\frac{B_z}{y} - \frac{B_y}{z}\right) = \alpha\frac{\rho}{k'_e}$$

or: $$\left.\frac{E'_x}{t}\right)_{S'} = 0 = \left.\frac{E_x}{t}\right)_{S'} = \left.\frac{E_x}{t}\right)_{S} + u\frac{E_x}{x}$$

implies: $$\frac{E_x}{t}\frac{(1 - \alpha^2)}{u} + \text{div } \mathbf{E} - u\left(\frac{B_z}{y} - \frac{B_y}{z}\right) = \alpha\frac{\rho}{k'_e}$$ or :

(7) $$\frac{B_z}{y} - \frac{B_y}{z} = \frac{1}{c^2}\frac{E_x}{t} + \frac{\text{div}\mathbf{E}}{u} - \frac{\alpha\rho}{uk'_e}$$

Furthermore **rot B' = 0** by assumption. Therefore:

$$\frac{\partial B'_z}{\partial y'} - \frac{B'\ y}{z'} = 0$$ and, by substitution:

(7') $$\frac{B\ z}{y} - \frac{B\ y}{z} = \frac{1}{c^2}\frac{E\ x}{t} + \frac{u\mathrm{div}\mathbf{E}}{c^2}$$

By comparing (7) and (7'), we get:

$$\mathrm{div}\ \mathbf{E}\ [\ 1 - \frac{u^2}{c^2}\ ] = \frac{\alpha\rho}{k'_e} \qquad \text{or} \qquad \mathrm{div}\ \mathbf{E} = \frac{\rho}{\alpha k'_e}$$

The Gauss theorem applied to the electric field is conserved in (S) if:

$$\frac{k_e}{k'_e} = \alpha = \sqrt{1 - \frac{u^2}{c^2}}$$ and we can write:

$$\mathrm{div}\ \mathbf{E} = \frac{\rho}{k_e}$$ [Gauss's theorem in (S)]

You can then note that the electric permittivities are different in (S) and (S').

It then follows that:

$$-\frac{B\ y}{z} = \frac{1}{c^2}\frac{E\ y}{t} + \frac{u\rho}{k_e c^2}\ \frac{B\ z}{y}$$

(8') $$\frac{B\ z}{y} - \frac{B\ y}{z} = k_m \rho u + \frac{1}{c^2}\frac{E\ y}{t}$$

Likewise: $$\frac{B'\ x}{z'} - \frac{B'\ z}{x'} = 0$$ and $$\frac{B'\ y}{x'} - \frac{B'\ x}{y'} = 0$$ implies:

(8'') $$\frac{B\ x}{z} - \frac{B\ z}{x} = \frac{1}{c^2}\frac{E\ y}{t}$$ and:

(8''') $$\frac{B\ y}{x} - \frac{B\ x}{y} = \frac{1}{c^2}\frac{E\ z}{t}$$ and since $\mathbf{j} = \rho\ \mathbf{u}$:

(8) $$\frac{1}{k_m}\ \mathbf{rot}\ \mathbf{B} = \mathbf{j} + k_e \frac{\mathbf{E}}{t}$$ [Maxwell-Ampere equation in (S)]

Speed of light and electromagnetic constants in the reference systems (S) and (S')

I have proved that:

$$c' = c\sqrt{\frac{c - u}{c + u}}$$

but: $k'_e \, k'_m \, c'^2 = 1$ and $k'_e = \dfrac{k_e}{\sqrt{1 - \dfrac{u^2}{c^2}}} = \dfrac{c\, k_e}{\sqrt{c^2 - u^2}}$

or:

$$\frac{c\, k_e}{\sqrt{c^2 - u^2}} \; k'_m \; c^2 \frac{c - u}{c + u} = 1$$

$$k'_m = k_m \frac{(c + u)^{3/2}}{c\sqrt{c - u}} = k_m \frac{c + u}{c'}$$

Magnetic permeabilities are different in (S) and (S').

I have just showed that transformation (T):

$$\begin{cases} x = \sqrt{1 - \dfrac{u^2}{c^2}}\; x' + u\, t \\ y = y' \\ z = z' \end{cases}$$

conserves the form of Maxwell's equations in the case where the charges are static with respect to one of the galilean referentials. Here (S') is the preferred referential.
I have derived the electric field transformation rules:

$$\begin{cases} E'_x = \alpha\, E_x \\ E'_y = E_y - u\, B_z \\ E'_z = E_z + u\, B_y \end{cases}$$

For the time being, I have accepted (without proof) the magnetic field transformation rules, formally identical to those of special relativity:

$$\begin{cases} B'_x = \lambda B_x \\ B'_y = \dfrac{\lambda}{\alpha}\left(B_y + \dfrac{u}{c^2} E_z\right) \\ B'_z = \dfrac{\lambda}{\alpha}\left(B_z - \dfrac{u}{c^2} E_y\right) \end{cases}$$

The speed of light, the magnetic permeability and the electric permittivity all depend on the considered referential.

Note that **Galileo's relativity principle** does not apply.

Preferred referential. Physical interpretation of transformation (T)

In referential (S'), the charges are static. (S') is the preferred referential. For any other referential, these charges are undergoing rectilinear and uniform motion.

Let us consider a length of coordinates $(x_1, x_2)_S$ and $(x'_1, x'_2)_{S'}$ at time t.

The equations for (T) imply:

$$x_1 = \sqrt{1 - \frac{u^2}{c^2}}\ x'_1 + u\,t$$

$$x_2 = \sqrt{1 - \frac{u^2}{c^2}}\ x'_2 + u\,t$$

$$x'_2 - x'_1 = (x_2 - x_1)\frac{c}{\sqrt{c^2 - u^2}} \qquad \text{therefore :} \qquad x'_2 - x'_1 > x_2 - x_1$$

When looked at from the preferred referential (S') where charge is static, distances are dilated. (S') can then be considered as an absolute referential: this dilatation of distances can be considered as the physical expression of the expansion of the universe, hypothesis I will take to be true.

Generalization to ordinary galilean referentials.

Notation change

Let (S) and (S') be two ordinary galilean referentials and let us suppose the existence of a preferred galilean referential (S") where electric charge is "at rest".
(S) and (S') are moving with speed **u** and **u'** with respect to (S")
u and **u'** are collinear to the Ox axis
With no new calculations, it can be proved that Maxwell's equations are conserved in (S) and (S').
You just need to apply the preceding theory to (S) and (S"), then to (S') and (S").
Maxwell's equations being invariant in (S) and (S") [both the magnetic field and the electric field are static in (S")] and in (S') and (S"), they are therefore invariant in (S) and (S').

I wrote down the complete transformation formulas.

$$(T)\begin{cases} x = \alpha x'' + u\,t \\ y = y'' \\ z = z'' \end{cases} \qquad \alpha = \sqrt{1 - \frac{u^2}{c^2}}$$

c : speed of light in (S)

$$(T')\begin{cases} x' = \alpha' x'' + u't \\ y' = y'' \\ z' = z'' \end{cases} \qquad \alpha' = \sqrt{1 - \frac{u'^2}{c'^2}}$$

c' : speed of light in (S')

Electric field

$$\begin{cases} E'_x = \alpha\, E_x = \alpha' E'_x \\ E'_y = E_y - uB_z = E'_y - u'B'_z \\ E''_z = E_z + uB_y = E'_z + u'B'_y \end{cases}$$

Magnetic field

$$\begin{cases} B''_x = \lambda B_x = \lambda' B'_x \\ B''_y = \frac{\lambda}{\alpha}\left(B_y + \frac{u}{c^2} E_z\right) = \frac{\lambda'}{\alpha'}\left(B'_y + \frac{u'}{c'^2} E'_z\right) \\ B''_z = \frac{\lambda}{\alpha}\left(B_z - \frac{u}{c^2} E_y\right) = \frac{\lambda'}{\alpha'}\left(B'_z - \frac{u'}{c'^2} E'_y\right) \end{cases}$$

Transformations (T) and (T') imply:

$$x = \frac{\alpha}{\alpha'}\, x' + \left(u - \frac{\alpha}{\alpha'} u'\right) t$$

under the form:

$$\begin{cases} x = ax' + wt \\ y = y' \\ z = z' \end{cases} \qquad \text{with: } a = \frac{\alpha}{\alpha'} \qquad w = u - \frac{\alpha}{\alpha'}\, u'$$

w is the relative speed of (S) with respect to (S'), different from the **relative galilean speed (u – u')**.

Differentiation formulas

Let **A** be a field vector (electric or magnetic).

We have: $\left.\frac{\mathbf{A}}{t}\right)_{S''} = 0 = \left.\frac{\mathbf{A}}{t}\right)_S + u\frac{\mathbf{A}}{x} = \left.\frac{\mathbf{A}}{t}\right)_{S'} + u'\frac{\mathbf{A}}{x'}$

$$\frac{\mathbf{A}}{x'} = a\frac{\mathbf{A}}{x} \quad \text{and} \quad \left.\frac{\mathbf{A}}{t}\right)_{S'} = \left.\frac{\mathbf{A}}{t}\right)_{S} + w\frac{\mathbf{A}}{x}$$

Speeds

$$\begin{cases} v_x = \dfrac{dx}{dt} = a\dfrac{dx'}{dt} + w = av'_x + w \\ v_y = v'_y \\ v_z = v'_z \end{cases}$$

Speeds of light

$c = ac' + w$ and by substituting:

$$c\sqrt{\frac{c - u}{c + u}} = c'\sqrt{\frac{c' - u'}{c' + u'}} = c'' \qquad \text{speed of light in (S'')}$$

$\Rightarrow$ Note that **Galileo's relativity principle** applies to (S) and (S'):

(S) $\Rightarrow$ (S') (S') $\Rightarrow$ (S)

$x \Rightarrow x'$ $\alpha \Rightarrow \alpha'$ $u \Rightarrow u'$

We get:

$$x' = \frac{\alpha}{\alpha'}x + \left(u' - \frac{\alpha'}{\alpha}u\right)t \qquad \text{from where:} \qquad x = \frac{\alpha}{\alpha'}x' + \left(u - \frac{\alpha}{\alpha'}u'\right)t$$

The same goes for electric and magnetic fields.

Electric permittivity

$k_e = k''_e\alpha$ $k'_e = k''_e\alpha'$

$$k_e = \frac{\alpha}{\alpha'}k'_e = ak'_e = \frac{c'}{c}\sqrt{\frac{c^2 - u^2}{c'^2 - u'^2}}\ k'_e$$

Magnetic permeability

The formulas $k_e k_m c^2 = 1$ and $k'_e k'_m c'^2 = 1$ imply:

$$k_m = \frac{c'}{c}\sqrt{\frac{c'^2 - u'^2}{c^2 - u^2}}\ k'_m$$

<u>Derivation of λ and λ'. Alternative form of the magnetic and electric field transformation formulas.</u>

In special relativity, it is easily shown that:

(9) $$\mathbf{E}^2/c^2 - \mathbf{B}^2 = \mathbf{E}'^2/c^2 - \mathbf{B}'^2$$

(10) $$\mathbf{E.B} = \mathbf{E'.B'}$$

We can try to keep the same kind of formulas. Equation (9) can be written:

$$\mathbf{D}^2 / k_e^2\, c^2 - k_m^2\, \mathbf{H}^2 = \mathbf{D}'^2 / k_e^2\, c^2 - k_m^2\, \mathbf{H}'^2$$

H and **H'** being the auxiliary fields and **D** and **D'** being the electrical displacements in (S) and (S').

By using $k_m k_e c^2 = 1$, we get:

$$\mathbf{D}^2 - \mathbf{H}^2/c^2 = \mathbf{D}'^2 - \mathbf{H}'^2/c^2$$

With transformation (T), we would get:

(9') $$\mathbf{D}^2 - \mathbf{H}^2/c^2 = \mathbf{D}'^2 - \mathbf{H}'^2/c'^2$$

Likewise, for equation (10):

$$\mathbf{D}/k_e\, k_m\mathbf{H} = \mathbf{D}'/k_e\, k_m\mathbf{H}' \qquad \text{or} \qquad \mathbf{D}.\mathbf{H}/c = \mathbf{D}'.\mathbf{H}'/c$$

With transformation (T), we would get:

(10') $$\mathbf{D}.\mathbf{H}/c = \mathbf{D}'.\mathbf{H}'/c'$$

I will try to derive λ and λ' to satisfy equations (9') and (10'). After calculations, we get:

$$\lambda / \lambda' = c/c'\ k_e / k'_e = c'/c\ k'_m/k_m$$

(λ and λ' are only present through their ratio)

Here are the transformation formulas for the auxiliary field and the electrical displacement:

$$(11)\quad \begin{cases} D'_x = D_x \\ D'_y = 1/\alpha\ (D_y - u/c\ H_z) \\ D'_z = 1/\alpha\ (D_z + u/c\ H_y) \end{cases}$$

$$(12)\quad \begin{cases} H'x\ /c' = Hx\ /c \\ H'y\ /c' = 1/\alpha c\ (Hy + u\ Dz) \\ H'z\ /c' = 1/\alpha c\ (Hz - u\ Dy) \end{cases}$$

These only apply in the case where charge is at rest in (S').

In the general case where (S) and (S') are two ordinary referentials, the transformation formulas written under the form of page 35, as functions of u, u', α, α', with $\alpha^2 = 1 - u^2/c^2$ and $\alpha'^2 = 1 - u'^2/c'^2$ get pretty complicated. On the other hand, one can prove that these formulas can be written as functions of **c** and **c'** exclusively. These are the following equations:

$$(13)\quad \begin{cases} D'x\ = Dx \\ D'y\ = k1\ Dy - k2\ \dfrac{Hz}{c} \\ D'z\ = k1\ Dz + k2\ \dfrac{Hy}{c} \end{cases}$$

$$(14)\quad \begin{cases} \dfrac{H'x}{c'} = \dfrac{Hx}{c} \\ \dfrac{H'y}{c'} = k1\ \dfrac{Hy}{c} + k2\ Dz \\ \dfrac{H'z}{c'} = k1\ \dfrac{Hz}{c} - k2\ Dy \end{cases}$$

with : $k_1 = 1/2(c/c' + c'/c)$

$k_2 = 1/2(c/c' - c'/c)$

These equations are perfectly symmetrical. You can easily check that Galileo's relativity principle applies.
Starting with (13) and changing (S) into (S') and (S') into (S):

$$D_x = D'_x$$

$$D_y = k_1\ D'_y + k_2\ \frac{H'_z}{c'}$$

$$D_z = k_1\ D'_z\ -\ k_2\ \frac{H'_y}{c'}$$

and, according to (13), (14) can be re-derived for the H'y/c' component and the H'z/c' component. Furthermore, we can prove that H'x/c' = Hx/c is necessarily true : if , in H'x/c' expression, there were other components than Hx/c, inversely, in the expression of one of these components, D_y for instance, we should find H'x/c' ; however, it is not present. Therefore H'x/c' depends only on Hx/c and is equal to it by reciprocity .

In conclusion Equation (14) was derived from equation (13).

By setting $\mathbf{h} = \frac{\mathbf{H}}{c}$ (which has the same dimension as **D**), Maxwell's equations can be written:

$$\text{div}\,\mathbf{h} = 0 \qquad \text{div}\,\mathbf{D} = \rho$$

$$\mathbf{rot\ D} = -\frac{\mathbf{h}}{ct} \qquad \mathbf{rot\ h} = \frac{\mathbf{j}}{c} + \frac{\mathbf{D}}{ct}$$

As a reminder, here is the equation that links **c** to **c'** in the special case electromagnetic waves propagating along the Ox axis:

$$c\sqrt{\frac{c - u}{c + u}} = c'\sqrt{\frac{c' - u'}{c' + u'}}$$

APPENDIX

This new theory, based on the existence of an absolute referential linked to the Universe itself, is not in contradiction with the criticism on relativity emitted by Léon Brillouin (ref 5 and 6) and in particular with the fact that a reference system must have an infinite mass. Furthermore, the hypothesis that permits the variability of the speed of light seems in accordance with the measurements done by Miller and Maurice Allais (ref 25).

Let's not forget that this new theory is only an "approximation"(similarly to relativity) of physical reality since I got rid of the "real" universe's anisotropy, with its singular point.

To conclude, I would like to make a last remark: the center of the Universe, whose existence is inherent to this theory, can makes us think of the "Great Attractor" discovered a few years ago (ref 24).

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ADDENDUM

INTERPRETATION OF LIFETIME MEASUREMENTS ON "RELATIVISTIC" OR "ULTRARELATIVISTIC" PARTICLES

The relativity of time would be "proved" during lifetime measurements done on some particles (muons, pions, etc) produced and maybe accelerated to speeds close to the speed of light by the most powerful accelerators, like the CERN.
Without going into details, the following train of thought can be adopted in "special relativity":
u, the speed of the considered particles, is determined experimentally. **u** being very close to the speed of light, one can write:

$\beta = u / c = 1 - \varepsilon$ with $\varepsilon << 1$

If we call $\Delta t'$ the lifetime of the particle in its own referential and Δt its lifetime in the laboratory's referential, special relativity gives us the following formula:

$$\Delta t = \Delta t' / \sqrt{1 - \beta^2}$$

Numerical example:

with $\beta = 0.99875$
we find $\Delta t = 20\ \Delta t'$, in agreement with experimental results

Cosmophysical interpretation of these results.

First of all, note that:

1) In theory the calculation of the particle's speed must be done and it is effectively done in special relativity. Then the calculation of its energy and lifetime can be done.

In different terms, the theoretical Δt was evaluated using relativistic formulas.

Let's just suppose for the moment that the value of this theoretical Δt is independent of any theory, relativistic or not.

2) In reality during this type of experiment, Δt is not directly measured: the total distance traveled by the particle is measured.

Let x be this distance in the lab's frame. We have:
$\Delta x = u\ \Delta t = c\ (1 - \varepsilon)\ \Delta t$ # $c\ \Delta t$

c being independent from the considered referential, one should find , in the particle's referential, a distance $\Delta x'$ such as:

$$\Delta x' = c\ \Delta t'$$

We have: $\Delta x/\Delta x' = \Delta t/\Delta t' = 1/\sqrt{1-\beta^2}$

On the other hand in cosmophysics if lifetimes are identical, the speeds of light are different:

We have:

$$c = c'\sqrt{c+u}/\sqrt{c-u} = c'\sqrt{1+\beta}/\sqrt{1-\beta}$$

and: $\Delta x^* = c\,\Delta t$ $\Delta x'^* = c'\,\Delta t$

$$\Delta x^*/\Delta x'^* = c/c' = \sqrt{1+\beta}/\sqrt{1-\beta} = 1+\beta/= (1+\beta)\,\Delta x/\Delta x' \approx 2\Delta x/\Delta x'$$

β^2

This important result follows:

⇒ In cosmophysics, the calculated length is twice the length calculated in relativity.
The order of magnitude is correct. The 2 factor must be explained, but remember I supposed the Δt theorical to be identical in both theories and this is not proved to be true.