Title :ETHER, DARK MATTER AND TOPOLOGY OF THE UNIVERSE(version3)

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Abstract:

The article is divided in 2 parts. In the 1st part (PART I), we emit the hypothesis that a substance, called ether-substance, fills and constitutes all what is called "vacuum" in the Universe. We assume that it has a mass and consequently it could be the nature of dark matter. Modeling it as an ideal gas, we obtain the flat rotation curve of spiral galaxies. Using a very simple model of thermal transfer between baryonic particles and ether-substance, we obtain the baryonic Tully-Fisher's law. Then we emit the hypothesis of the existence at every point of the Universe, of a particular Referential called "local Ether". We will see that both previous concepts of ether can be detected experimentally. So we will call "Cosmology based on ether" (CBE) Cosmology based on the previous concepts of ether. In this CBE, topology of the Universe is much simpler than topologies obtained by the Standard Cosmological model (SCM), in particular in the 1st model. Indeed, contrary to MSC, the 1st model of CBE does not need dark energy nor Cosmological constant, nor complicated mathematics based on General Relativity. Nonetheless, it permits to obtain a very simple Hubble's constant, in 1/t, t age of the Universe, and to predict the different cosmological distances in agreement with observation. CBE permits also to interpret, contrary to MSC, the Referential in which fossil radiation is isotropic. Nonetheless, CBE remains compatible with Special and General Relativity.

In the 2nd part (PART II) we will study some problems raised by PART I (motion of galaxies inside the intergalactic ether-substance, concentration of ether-substance around stars..)

Key words: Topology of the Universe, Tully-Fisher's law, dark matter, fossil radiation, ether.

## 1.INTRODUCTION (PART I)

After the theory of Special Relativity was admitted, the idea of ether has been abandoned in physics. Indeed it appeared that the existence of ether was not necessary in order to explain the results of experiments in general physics, in particular in particle physics and electromagnetism.

In this article, we will see that new concepts of ether, different and more elaborated than the pre-relativistic concept of ether, appear to be fundamental in Cosmology, because they permit to interpret many observations that cannot be interpreted in the Standard Cosmological model [(5)(6)(9)] (SCM), for instance the flat rotation curve of galaxies, the Tully-Fisher's law, a simple topology of Universe, the Referential in which fossil radiation is quasi isotropic…We will see that both introduced concepts of ether can be detected experimentally. Nonetheless we will see that this new Cosmology, called Cosmology based on Ether (CBE) interprets successfully all astronomical observations that were previously only interpreted by SCM, and moreover is compatible with Special and General Relativity.

The 3 fundamental following points, that were valid in SCM, remain valid in CBE:

1.The Universe is in expansion.

2.The factor of expansion 1+z interacts with the length of wave of photons and with distances between photons moving on the same axis exactly the same way as in SCM: They are increased by a factor 1+z.
3. The Big-Bang existed, and fossil radiation was emitted just after the Big-Bang.

We could have added in the point 2 that in CBE the factor of expansion 1+z is obtained using the equations of General Relativity in order to be closer to the SCM. We will do this in the second model of the CBE. But we will see in the 1st model of the CBE that it exists another solution that despite of its great simplicity permits to obtain predictions in agreement with all astronomical observations. (In particular a Hubble's constant in 1/t, t age of the universe, and commoving, angular and luminosity distance in agreement with observation).

The CBE is based on 4 simple Hypothesis, A,B,C,D . We will introduce a ***local Ether***, that is a local Referential (defined in each point of the Universe), an ***ether-substance***, that is a substance filling all Universe and an ***absolute Ether*** that is also a particular Referential. To begin with, we give the 2 first fundamental hypothesis, introducing the 2 first concepts (The 3rd concept will be introduced in the Hypothesis Da):

A.a)At any point of the Universe, it exists a very particular local Referential, called ***local Ether***, defining the *local rest*. Those particular local referentials define *absolute time* (indicated by clocks at rest in those referentials) that is the age of the Universe, and *local distances* (indicated by rules at rest in the local Referentials). If D is the local distance covered by a photon within an absolute time T, D=cT. This means that locally the velocity of light relative to this local Ether is equal to c Naturally we admit that physical laws have their classical expressions expressed in the local Ether.
(We could consider that this hypothesis A) contradicts Special Relativity (S.R) for which it does not exist a *special* frame of reference among all (local) Galilean Referentials. Nonetheless, we know that we can detect experimentally a Referential in which fossil radiation is quasi-isotropic. Let $R_{R.F}$ be this particular local Referential. $R_{.R.F}$ is the only local Galilean Referential in which the law "The fossil radiation is quasi-isotropic in R" is valid. Consequently we can consider that $R_{R.F}$ is a special Referential, because despite that it seems to contradict Special Relativity, its existence is an experimental fact. We will see that it is this Referential $R_{R.F}$ that will be identified to the local Ether. Consequently local Ether can be detected experimentally. Nonetheless, we can admit that Special Relativity remains true for usual physical laws (in electromagnetism, particle physics…). Then the local Ether, as any (local) Galilean Referential, is a Lorentz Referential. We remind that also the result of the experiences of A.Aspect connected to quantum intrication [(7)] could be considered as contradicting Special Relativity. Indeed they imply that an information can be transmitted faster than light.

We remark that the existence of such a local special Referential $R_{R.F}$ is on the contrary fully in agreement with a theory interpreting all the experimental observations considered as relativistic but admitting the existence of a local special Galilean Referential [(2)(3)] . We remind that this theory was also in complete agreement with the experiences of A.Aspect).

b) The velocity (in norm and vector, assuming that local ethers have parallel axes) relative to a local ether (called *local velocity*) of a photon keeps itself.

B.The Universe is filled by a substance, called ***ether-substance*** ,constituting what is called (wrongly) "the vacuum". It owns a mass and can be modeled as an ideal gas.

(This ether-substance is only submitted to gravitational interaction. So we cannot detect it using electromagnetic, weak and strong interaction. But we will see that we can detect it using gravitational interaction (flat rotation curve of galaxies)).

We see that the points 1,2,3 of SCM previously admitted are a priori compatible with the hypothesis A,B of the CBE. In fact those points 1,2,3 are consequences of hypothesis A,B,C,D. We saw that the local Ether and ether-substance, concepts on which is based the CBE, can be detected experimentally (observing fossil radiation and the rotation curve of galaxies).

We will introduce in the hypothesis C a thermal transfer between baryons and ether-substance. Using the hypothesis B,C we will obtain a theoretical justification of the flat rotation curve of galaxies and of the baryonic Tully-Fisher's law.

In the hypothesis D we will define the form of the Universe and we will complete the definition of local Ethers, at each point of the Universe. We will then interpret the observations of Cosmological distances, of Hubble's constant, of fossil radiation, of supernova explosions… In order to interpret those observations we will propose 2 models: The 2$^{nd}$ model of the CBE is based on mathematics of General Relativity as SCM. So it should need the existence of dark energy and of a Cosmological constant. The 1$^{st}$ model of the CBE is on the contrary based on very simple mathematics, and does not need the existence of dark energy nor of a Cosmological constant.

We will see that CBE appears to be an alternative to MOND theory [9][10] in order to interpret phenomena linked to dark matter. Naturally we define *local Galilean Referentials* as local Referentials with axes parallel to the axes of the local Ether, and driven with a constant velocity relative to it. We remind that in CBE we can keep the 1$^{st}$ Principle of Special Relativity (except for the law "Fossil radiation is isotropic in R" that is an experimental fact). Then local Ethers and Galilean Referentials are Lorentz Referentials.

## 2. DARK MATTER

### 2.1 Nature of Dark matter-Its invisibility.

If we admit that the ether-substance has a mass, then it is clear that dark matter could be constituted of ether-substance. So this gives the nature of dark matter and the origin of its invisibility, because it constitutes what is called (wrongly) "the vacuum" and consequently it is obviously transparent.

### 2.2 Flat rotation curves of galaxies.

If we model the ether-substance as an ideal gas, and if we consider that galaxies are concentrations of ether-substance, we obtain that the velocities of stars are independent of their distance to the center the galaxy, which was an unresolved enigma in the SCM.

So we make the following hypothesis that the ether-substance can be modeled as an ideal gas:

An element of Ether-substance with a mass m, a volume V, a pressure P and a temperature T verifies the law, $k_0$ being a constant:

$$PV=k_0mT \qquad (1)$$

Which means, setting $k_1=k_0T$ :

$PV=k_1m$ (2)

Or equivalently, ρ being the density of the element:

$P=k_1\rho$ (3a)

We then emit the natural hypothesis that a galaxy can be modeled as a concentration of Ether-substance presenting a spherical symmetry, at a constant and homogeneous temperature T.
We then consider the spherical surface S(r) (resp. the spherical surface S(r+dr)) that is the spherical surface with a radius r (resp. r+dr) and whose the center is the center O of the galaxy. S(O,r) is the full sphere of radius r and of center O.

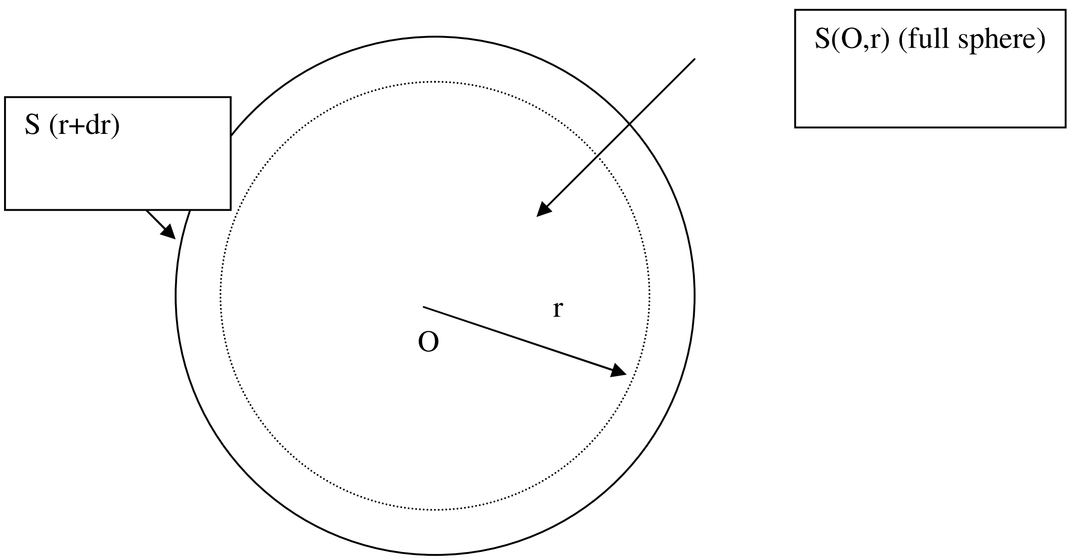


Figure 1:The galaxy concentration of ether-substance

The mass M(r) of the full sphere S(r)is given by:

$$M(r)=\int_0^r \rho(x)4\pi x^2 dx \qquad (3b)$$

We then consider the following equation (4) of equilibrium of forces on an element of Ether-substance with a surface dS, a width dr, situated between the 2 spheres S(O,r) and S(r+dr):

$$dSP(r+dr)+\frac{G}{r^2}(\rho(r)dSdr)(\int_0^r \rho(x)4\pi x^2 dx)-dSP(r)=0 \qquad (4)$$

Eliminating dS, we obtain the equation:

$$\frac{dP}{dr}=-\frac{G}{r^2}(\rho(r))(\int_0^r \rho(x)4\pi x^2 dx) \qquad (5)$$

And using the equation (3), we obtain the equation:

$$k_1 \frac{d\rho}{dr} = -\frac{G}{r^2}(\rho(r))(\int_0^r \rho(x)4\pi x^2 dx) \qquad (6)$$

We then verify that the density of the ether-substance ρ(r) satisfying the preceding equation of equilibrium is:

$$\rho(r) = \frac{k_2}{4\pi r^2} \qquad (7)$$

(A density of dark matter expressed as in Equation (7) has already been proposed in order to explain the flat rotation curve of spiral galaxies, but here not only we justify the invisibility of this dark matter, but also we give a theoretical justification of this expression (7), consequence of the model of ether-substance as an ideal gas, Equation (1))

The constant $k_2$ is given by, G being the Universal attraction gravitational constant:

$$k_2 = \frac{2k_1}{G} = \frac{2k_0 T}{G} \qquad (8)$$

Using the preceding equation (7), we obtain that the mass M(r) of the sphere S(O,r) constituted of Ether-substance is given by the equation:

$$M(r) = \int_0^r 4\pi x^2 \rho(x) dx = k_2 r \quad (9)$$

We then obtain, neglecting the mass of stars in the galaxy, that the velocity v(r) of a star of a galaxy situated at a distance r from the center O of the galaxy is given by $v(r)^2/r = GM(r)/r^2$ and consequently :

$$v(r)^2 = Gk_2 = 2k_1 = 2k_0T \qquad (10)$$

So we obtain in the previous equation (10) that the velocity of a star in a galaxy is independent of its distance to the center O of the galaxy, solving the 3rd enigma concerning dark matter. (We previously solved the enigma of the nature of dark matter and of its invisibility).

We note that the theoretical elements of the new Cosmology permitting to obtain the equations (7)(8)(9)(10) are compatible with Special and General Relativity Principles.

## 2.3 Baryonic Tully-Fisher's law.

*2.3.1 Recall.*

We remind that the Tully-Fisher's law is the following:
Tully and Fisher realized some observations on spiral galaxies with a flat rotation curve. They obtained that the luminosity L of such a spiral galaxy is proportional to the 4th power of the velocity v of stars in this galaxy. So we have the Tully-Fisher's law for spiral galaxies, $K_1$ being a constant:

$$L = K_1 v^4 \qquad (11)$$

But in the case studied by Tully and Fisher, the baryonic mass M of a spiral galaxy is usually proportional to its luminosity L. So we have also the law for such a spiral galaxy, $K_2$ being a constant:

$$M=K_2v^4 \qquad (12)$$

This $2^{nd}$ form of Tully-Fisher's law is known as the *baryonic Tully-Fisher's law*.

The more recent observations of Mc Gaugh [(1)] show that the baryonic Tully-Fisher's law (12) seems to be true for all galaxies with a flat rotation curve, including those galaxies with a luminosity not proportional to their baryonic mass. This constitutes a $4^{th}$ major enigma concerning dark matter for SCM, but we are going to see that CBE permits to solve this new enigma.

*2.3.2 Theory of quantified loss of calorific energy (by nuclei).*

We saw in the previous equation (10) that according to CBE the square of the velocity of stars in a galaxy is proportional to the temperature of the concentration of Ether-substance constituting this galaxy. So we need to determine T:

-A first possible idea is that the temperature T is the so called "Temperature of the fossil radiation". But this is impossible because it would imply that all stars of all galaxies are driven with the same velocity and we know that it is not the case.

-A second possible idea is that in the considered galaxy, each baryon interacts with the ether-substance constituting the galaxy, transmitting to it a calorific energy. This thermal energy is very low, but because of the very low density of ether-substance and of the considered times (we remind that the diameter of galaxies is if the order of 100000 light-years), it can lead to appreciable temperatures of ether-substance. A priori we could expect that this loss of calorific energy for each baryon (transmitted to the ether-substance) depends on the temperature of this baryon and of the temperature T of ether-substance, but if it was the case, the total calorific loss for all baryons would be extremely difficult to calculate and moreover it should be very probable that we would then be unable to obtain the very simple baryonic Tully-Fisher's law.

We are then led to make the most simple hypothesis defining the thermal transfer between ether-substance and baryons:

Hypothesis Ca):

-Each nucleus of atom in a galaxy is submitted to a loss of calorific energy, transmitted to the concentration of Ether-substance constituting the galaxy.

-This loss of calorific energy depends only on the number of nucleons constituting the nucleus (It is independent of its temperature). So if p is the thermal power corresponding to the loss of calorific energy for a nucleus of atom with n nucleons, it exists a constant $p_0$ (loss of calorific energy per nucleon) such that:

$$p=np_0 \qquad (13)$$

According to the equation (13), the total thermal power corresponding to the loss of calorific energy by all the atoms of a galaxy is proportional to the baryonic mass of this galaxy. So if $m_0$ is the mass of one nucleon, M being the baryonic mass of the galaxy, we obtain according to the equation (13) that the total thermal power $P_r$ received by the concentration of Ether-substance constituting the galaxy from all the atoms is given by the following equation, $K_3$ being the constant $p_0/m_0$:

$$P_r=(M/m_0)p_0=K_3M \qquad (14)$$

Concerning the preceding hypothesis Ca):

-It is possible that this hypothesis be true only for atoms whose temperature be superior to the temperature T of the concentration of ether-substance.

-The great simplicity of this hypothesis Ca) permits to obtain very easily the total power corresponding to calorific energy received by the concentration of Ether-substance (Equation (14)). If the loss of energy of a nucleus of atom depended on its temperature, then it would be incomparably more complicated, and maybe impossible, to obtain a simple expression giving this total power.

-This hypothesis is a priori compatible with the Special and General Relativity Principles, and also with classical Quantum Physics.

*2.3.3 Obtainment of the baryonic Tully-Fisher's law.*

In agreement with the previous model of galaxy, we model a galaxy as a concentration of ether-substance presenting a spherical symmetry and being itself a sphere, at a temperature T and surrounded itself by a medium constituted by ether-substance (called "intergalactic ether-substance") at a temperature $T_0$ and with a density $\rho_0$.

In order to obtain the radius R of the concentration of Ether-substance constituting the galaxy, it is natural to make the hypothesis of the continuity of $\rho(r)$: R is the radius for which the density $\rho(r)$ of the concentration of Ether-substance is equal to $\rho_0$. So we have the equation:

$$\rho(R)=\rho_0 \qquad (15)$$

Consequently we have according to the equations (7) and (8):

$$\frac{k_2}{4\pi R^2}=\rho_0 \qquad (16)$$

$$\frac{2k_0T}{G}\times\frac{1}{4\pi R^2}=\rho_0 \qquad (17)$$

So we obtain that the radius R of the concentration of Ether-substance constituting the galaxy is given approximately by the equation:

$$R=(\frac{2k_0T}{4\pi G\rho_0})^{1/2}=K_4T^{1/2} \qquad (18)$$

The constant $K_4$ being given by :

$$K_4=(\frac{2k_0}{4\pi G\rho_0})^{1/2} \qquad (19)$$

We can then consider that the sphere with a radius R of Ether-substance constituting the galaxy is in thermal interaction with the medium of ether-substance at a temperature $T_0$ surrounding it (intergalactic ether-substance). We make the hypothesis C)b):

The thermal interaction between the ether-substance constituting the galaxy (at a temperature T) and the surrounding intergalactic ether-substance (at a temperature $T_0$) is a convective transfer.

We know that if φ is the thermal flow of thermal energy on the borders of the spherical concentration of ether-substance with a radius R, $P_l$ being the power lost by the spherical concentration of ether-substance constituting the galaxy is given by the equation:

$$P_l=4\pi R^2\varphi \qquad (20)$$

But we know that according to the definition a convective transfer between a medium at a temperature T and a medium at a temperature $T_0$ and according to the previous hypothesis Cb) the flow φ between the 2 media is given by the expression, h being a constant depending only on $\rho_0$:

$$\varphi=h(T-T_0) \qquad (21)$$

Consequently the total power lost by the concentration of eher-substance is:

$$P_l=4\pi R^2h(T-T_0) \qquad (22)$$

We can consider that at the equilibrium, the thermal power $P_r$ received by the spherical concentration of ether-substance constituting the galaxy is equal to the thermal power $P_l$ lost by this spherical concentration. Consequently according to the equations (14) and (22), (M being the baryonic mass of the galaxy), we have:

$$K_3M=4\pi R^2h(T-T_0) \qquad (23)$$

Using then the equation (18) :

$$K_3M=4\pi K_4^2hT(T-T_0) \qquad (24)$$

Making the approximation $T_0<<T$ :

$$M=4\pi\frac{K_4^2}{K_3}hT^2 \qquad (25)$$

Consequently we obtain the expression of T, defining the constant $K_5$ :

$$T=\left(\frac{K_3}{4\pi K_4^2h}\right)^{1/2}M^{1/2}=K_5M^{1/2} \qquad (26)$$

And then according to the equation (10) :

$$v^2=2k_0T=2k_0K_5M^{1/2} \qquad (27)$$

So :

$$M = (\frac{1}{2k_0 K_5})^2 v^4 \qquad (28a)$$

So we finally obtain :

$$M=K_6v^4 \qquad (28b)$$

The constant $K_6$ being defined by:

$$K_6 = (\frac{1}{2k_0 K_5})^2 = \frac{4\pi K_4^2 h}{4k_0^2 K_3}$$

$$K_6 = \frac{4\pi h}{4k_0^2 K_3} \times \frac{2k_0}{4\pi G\rho_0}$$

$$K_6 = \frac{m_0 h}{2k_0 G\rho_0 p_0} \qquad (28c)$$

So we obtain the baryonic Tully-Fisher's law (12), with $K_2=K_6$. It is natural to assume that h depends on $\rho_0$. The simplest expression of h is $h=C\rho_0$, C being a constant. With this relation, $K_6$ is independent of $\rho_0$, and we can use the baryonic Tully-Fisher's law in order to define candles used to evaluate distances in the Universe.

**2.4 Temperature of the ether-substance.**

We introduced the temperature $T_0$ of the inter-galactic ether-substance. We could make the hypothesis that this temperature is the temperature of fossil radiation but we remind that in order to get the Tully-Fisher's law we supposed $T_0<<T$ (T temperature of the spherical concentration of ether-substance constituting galaxy). Consequently the previous hypothesis would lead to very high temperatures of concentrations of ether-substance constituting galaxies.

So we can be in the following situations:

a)The temperature $T_0$ of the intergalactic ether-substance (equation (21) is far less than the temperature of fossil radiation.
b)Baryons can emit thermal power towards ether-substance even if their temperature is inferior to the temperature of ether-substance, and thermal transfer from ether-substance towards baryons in nil or negligible.
c)The ether-substance does not interact with photons and in particular with fossil radiation. Consequently it does not receive radiated thermal transfer.

**2.5 Form of the Universe**

If the Universe was completely isotropic, we could expect by symmetry that the thermal flow through a great surface be nil. Consequently the temperature of the ether-substance inside a great sphere of the Universe (For instance with a radius of 1 billion years) should increase and tend to a uniform temperature of the ether-substance inside the sphere.

We know that it is not the case because galaxies have not the same temperature and moreover we admitted that the temperature of the intergalactic ether-substance is by far inferior to the temperature of the spherical concentrations of ether-substance constituting galaxies. So an infinite isotropic Universe would contradict our model of CBE permitting to obtain the baryonic Tully-Fisher's law.

Nonetheless with the model of dark matter of the CBE, it is much more easy to define a finite Universe than in the SCM. Indeed we can consider in CBE that the Universe is a sphere constituted of ether-substance surrounded by a medium called "nothingness" that is different from ether-substance. This was not possible in the SCM that admitted the Cosmological Principle according to which the Universe was isotropic observed from any point. With the previous spherical model of the CBE, Universe is isotropic only if it is observed from points that are sufficiently far from its center. (We will explicit further at which conditions).

In the case in which Universe is a sphere constituted of ether-substance, we avoid in the CBE the previous contradiction. Indeed, we can assume in CBE, generalizing the hypothesis Cb), that at the borders of the Universe, there is a convective thermal transfer, between the intergalactic ether-substance at a temperature $T_0$ and the nothingness modeled as a medium with a temperature nil. Then the thermal flow lost by the Universe is, k being a variable or a constant:

$$\varphi=k(T_0-0)=kT_0 \qquad (28d)$$

M being the baryonic mass of the Universe, we obtain from equation (14) that the equation of thermal equilibrium is:

$$K_3M = 4\pi R^2\,\varphi = 4\pi R^2\,kT \qquad (29a)$$

So we see that if the Universe increases from a factor f, according to the equation (29a), if k is a constant (independent from the density of the intergalactic ether-substance), the temperature $T_0$ of the intergalactic ether-substance diminishes from a factor $f^2$. If we had supposed that $k=C_2\rho_0$, $\rho_0$ being the mass density of the intergalactic ether-substance and $C_2$ being a constant, it is very easy to obtain that if the Universe increases from a factor f, then T also increases by a factor f which is impossible.

We remark that our convective thermal model expressed in the hypothesis Cb) remains valid even if the galaxy is at rest relative to the surrounding intergalactic ether-substance.

### 2.6 Topology of the Universe-Law of Hubble ($1^{st}$ model)

If we consider a photon emitted from a point A at an absolute time $t_A$ (We remind that $t_A$ is the age of the Universe. See Hypothesis A in 1.INTRODUCTION) and arriving at a point B at an absolute time $t_B$, then we will call *time-back distance* between $A(t_A)$ and $B(t_B)$ the sum of elementary local distance covered by the photon between $t_A$ and $t_B$ $D=c(t_B-t_A)$.

Indeed according to the hypothesis A, we know that if the photon covers an elementary local distance dD within an interval of absolute time dt, we have dD=cdt. If we sum all those elementary distances and absolute intervals of time we obtain $D=c(t_B-t_A)$.

We have seen that some considerations led us to assume that the Universe could be modeled as a sphere filled of ether-substance. (We already studied such a spherical Universe, with borders moving at a velocity c, c velocity of light [(3)(4)] . Nonetheless in this Cosmological model, photons moved at an *absolute velocity* c, and there was not local Ether nor local velocity. But this model led to contradictions and we abandoned it. Nonetheless it permits to understand the following concept of ***absolute Ether***)

The introduction of local Ether permits to assume that the borders of the Universe can move at any *absolute velocity*, this absolute velocity being measured in a particular Referential, called ***absolute Ether***, whose center coincides with O center of the spherical Universe, whose time is the absolute time of the Universe and whose axes are fixed, parallel to the axes of local ethers, and give also local distances.

So we emit the hypothesis Da):

The Universe can be modeled as a swelling sphere whose borders move at an *absolute velocity* that is either a constant C ($1^{st}$ model) or is in obtained using the equations of General Relativity ($2^{nd}$ model). This *absolute velocity* is the velocity measured in a Referential, called ***absolute Ether***, whose center O is the center of the spherical Universe, whose axes are parallel to the axes of local Ethers, and whose times and distances are identical to those of local Ethers.

In order to define completely local Ethers, we define the commoving points of the swelling sphere the following way:

P(t) is any point belonging to the border of the swelling sphere , t being the age of the Universe, with **OP**(t) (O is the center of the swelling sphere) remaining in the same direction **u**, fixed vector of the absolute Ether. ( We have in the $1^{st}$ model of CBE, according to the hypothesis Da) $OP(t)=Ct=R_E(t)$, $R_E(t)$ radius of the swelling sphere).

A commoving point A(t) of the swelling sphere is defined by :

-A(t) remains on the segment [O,P(t)]

-OA(t)=aOP(t), a being a constant belonging to [0,1].

So in particular O and P(t) are commoving points of the swelling sphere. Moreover if A(t) and B(t) are 2 commoving points of the swelling sphere, belonging both to a radius [O,P(t)], and if $t_1$ and $t_2$ are 2 ages of the Universe, if $f=OP(t_2)/OP(t_1)$), (f will be called factor of expansion of the Universe between $t_1$ and $t_2$) then we have the 2 relations:

$$A(t_2)B(t_2)=fA(t_1)B(t_1)$$

And :

$$[A(t_2),B(t_2)]//[A(t_1),B(t_1)]$$

Using Thales theorem we obtain the 2 previous relation A(t) and B(t) being any commoving points of the swelling sphere (not compulsory belonging both to the same radius [O,P(t)]).

We remark that in the $1^{st}$ model , if A(t) is a commoving point of the swelling sphere, with preceding notations OA(t)=aCt, consequently the absolute velocity of A(t) (we remind that the absolute velocity is the velocity relative to the absolute Ether) is constant.

We can then complete the definition of local Ethers (See hypothesis A in 1.INTRODUCTION):

Hypothesis Db):

At each point of the Universe, the origin of the local Ether is the commoving point coinciding with it.

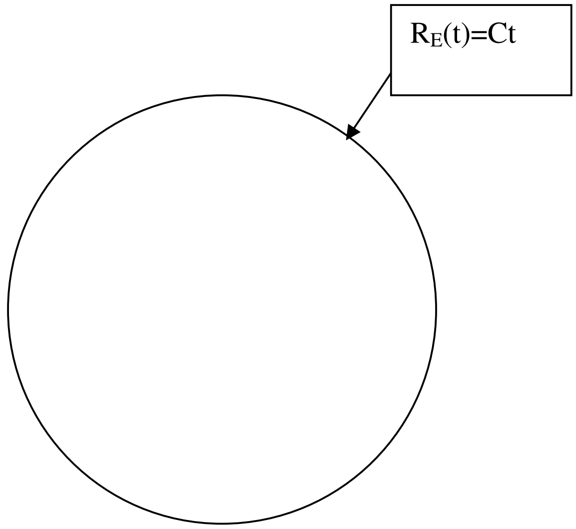


Figure 2:The model of the swelling sphere of the Universe (1st model).

We remind that according to the 1st model of the CBE, if A(t) is a commoving point of the swelling sphere, its absolute velocity is constant, as a vector or as a norm. Indeed we have seen with previous notations that OA(t)=aOP(t) and moreover **OA**(t) remains in the direction **u**. To begin with let us suppose the validity of this 1st model that is mathematically very simple, compared with the 2nd model that, as the SCM, use the mathematics of General Relativity.

We suppose that at the present age of the Universe $t_0$, we observe a photon emitted at an absolute time $t_Q$ coming from a point $Q(t_Q)$ situated at a time-back distance D of $O(t_0)$ (defined at the beginning of this section). We know according to the definition of time-back distance that a photon coming from $Q(t_Q)$ and arriving at $O(t_0)$ at the time $t_0$ was emitted at an absolute time $t_Q=t_0-D/c$. We know that at the time $t_Q$ the radius of the Universe was equal to $Ct_Q$ and at the time $t_0$ it was equal to $Ct_0$. Consequently the factor of expansion of the Universe between $t_Q$ and $t_0$ is (according to the 1st model of CBE):

$$1+z=(Ct_0)/(Ct_Q)=t_0/(t_0-D/c). \qquad (29b)$$

When $D/ct_0 \ll 1$ we obtain $z=D/ct_0$ and consequently the Hubble's constant is equal to $1/t_0$. The preceding equation is very simple and can easily be verified. For instance taking $t_0$=15 billion years , we know that for z=0.5, D=5 billion light years and we have $1+z=t_0/(t_0-D/c)$. For z=9 we obtain D=13.5 billion years.

It is important to remark that D is not the luminosity distance nor the angular distance, but the time-back distance that we defined as the distance that is the sum of elementary local distance covered by a photon.

We can define a luminosity distance, a commoving distance, an angular diameter distance that are completely analogous to those distances in classical Cosmology.

For instance let us suppose that we are at time $t_0$ in the center $O(t_0)$ of the Universe, and we observe a photon emitted by a galaxy with a redshift $z_0$. We suppose that this galaxy (observed with the redshift $z_0$) was at a commoving point $A(t_E)$ of the swelling sphere, when the photon was emitted at the age $t_E$ of the Universe. So A(t) is a commoving point of the swelling sphere.

Then according to our definition of the time-back distance, the time- back distance $D_{T.B}$ between $A(t_E)$ and $O(t_0)$ is, t being the absolute time (age) of the Universe :

$$D_{TB} = \int_{tE}^{t0} cdt \qquad (29c)$$

The local distance covered by the photon between t and t+dt is, according to the hypothesis A, equal to cdt. This local distance, considered as a distance between 2 commoving points of the swelling sphere, is increased by the factor of expansion of the Universe $1+z=t_0/t$ between t and $t_0$. We call ***commoving distance*** , in complete analogy with its definition in the SCM, the absolute distance $D_C$ between $A(t_0)$ and $O(t_0)$, that is the sum of the previous elementary local distances cdt increased by a factor $1+z=t_0/t$:

$$D_C = \int_{tE}^{t0} c(1+z)dt = \int_{tE}^{t0} c(t_0/t)dt \qquad (29d)$$

So we finally obtain the very simple expression of the commoving distance:

$$D_C=ct_0Log(t_0/t_E)=ct_0Log(1+z_0) \qquad (29e)$$

From this expression of $D_C$ we can easily define, in complete analogy with their definition in the SCM, the ***luminosity distance*** $D_L$ and the ***angular distance*** $D_A$ between $A(t_0)$and $O(t_0)$:

$$D_L=(1+z_0)D_C$$

$$D_A=D_C/(1+z_0) \qquad (29f)$$

So $D_A$ appears to be the absolute distance (measured in the absolute Ether) between $A(t_E)$ and $O(t_E)$.

$D_L$ appears to be the distance obtained using the conservation of the power emitted by a star, corrected by the effects of the factor of expansion of the Universe $1+z_0$, through a sphere whose the center is $A(t_0)$ and the radius is the absolute distance $A(t_0)O(t_0)$ (equal to $D_C$) (These effects are exposed in the point 2. of 1.Introduction (PART I)) .

We remark that if $V_E$ is the absolute velocity of the commoving point A(t),the absolute distance between $A(t_0)$ and $O(t_0)$, that we also called commoving distance, is also equal to $V_Et_0$. Consequently:

$$V_E=cLog(1+z_0) \qquad (29g)$$

We took an age of the Universe approximately equal to 15 billion years corresponding to a Hubble's constant $H=1/t_0$ approximately equal to 65 km/sMpc$^{-1}$ despite that it is generally admitted that the Hubble's constant H is approximately equal to 72km/sMpc$^{-1}$ corresponding to a time t=1/H approximately equal to 13,5 billion years.

But many astrophysicists disagree with a Hubble's constant approximately equal to 72 km/s Mpc$^{-1}$ and find a Hubble's constant approximately equal to 65km/sMpc$^{-1}$, for instance Tammann and Reindl [8] in a very recent article (October 2012). There is also a second possibility: Time-back distance could be superior to present estimations by a factor of 5% to 7%.

We can interpret in CBE the observation of a supernova explosion [5][11] the same way as in SCM: Indeed we have also in CBE (see point 2 of 1.INTRODUCTION, that is consequence of hypothesis A,D), that if the Universe is submitted to a factor of expansion f=1+z, then lengths of wave of photons and distance between 2 photons moving on the same axis increase also by a factor 1+z. This point 2 can be proved using the hypothesis A and D: We consider 2 photons ph1 and ph2, with the same local velocity (in vector), and towards the center O of the swelling sphere. ph1(t) and ph2(t) are the positions of the 2 photons at an absolute time t. We then consider what happens between t and t+dt, corresponding to a factor of expansion 1+df. We easily obtain:

ph1(t+dt)ph2(t+dt)=(1+df)ph1(t)ph2(t).

It is easily possible to generalize what precedes for 2 photons with identical local velocity (as a vector), but without supposing that this velocity is in the direction of O.

We justify the same way the interaction of the factor of expansion of the Universe with the length of wave of a photon. (We just model a photon as a system $A_1(t)A_2(t)$, $A_1(t)$ and $A_2(t)$ being two points driven with the local velocity of the photon and the distance $A_1(t)A_2(t)$ being the length of wave of the photon). This justification of the point 2. of the Introduction is valid for both models.

We always supposed that we make our observations from O, center of the Universe. But most of observations remain valid if we make our observations from O', O' being any commoving point of the Universe. Of course, the Universe is no more a sphere observed from O'. We then consider the Referential R' whose center is O', with axis parallel to the axis of R, giving the same absolute distances and time than R (and consequently local distances and times of local Ethers). Then definitions of time-back distance, commoving distance and angular and luminosity distance remain the same. We also obtain that commoving points (whose we keep the previous definition) keep a constant velocity relative to R'(as a vector and norm), and that the local velocities of a photon in R and R' are identical.

So we see that despite its great simplicity, the 1st model of the CBE remains in agreement with astronomical observations.

## 2.7 Evaluation of the constant C, velocity of the borders of the Universe. (1st model).

We suppose that we are in the 1st model of the CBE.

It is important to remark that according to the 1st model, C is not a priori equal to c. But we may expect that C is superior to c but is of the order of c (for instance 2c or 3c ).

The fact that we observe from our galaxy an isotropic Universe indicates that our galaxy should be close to the center O of the spherical Universe, or at a great distance from its borders. We remark that the Universe could be homogeneous but not compulsory. A non homogeneous Universe could explain why we do not observe traces of quasars and blue dwarfs in the neighborhood of our galaxy.

We can obtained informations concerning C, absolute velocity of the borders of the Universe using 2 methods, giving the same result:

In the 1st method we suppose that at an absolute time $t_E$, a photon is emitted from the borders of the Universe towards the center O of the spherical Universe. We call x(t) the distance between O and the photon at an absolute time t (age of the Universe). We call A(t) the commoving points coinciding with the photon at an absolute time t, and v(t) the absolute velocity of A(t). We have seen that we have the relation, using OA(t)=x(t):

$$x(t)=v(t)t \qquad (29h)$$

Moreover, remarking that the absolute velocity of the photon at time t is equal to v(t)-c:

$$x(t+dt)=x(t)+(v(t)-c)dt \qquad (29i)$$

Using x(t+dt)=v(t+dt)(t+dt) (Equation(29h):

$$v(t+dt)(t+dt)=v(t)t + (v(t)-c)dt \qquad (29j)$$

$$\frac{d}{dt}(v(t)t) = v(t) - c \qquad (29k)$$

$$\frac{d}{dt}(v(t)) = \frac{-c}{t} \qquad (29l)$$

$$v(t)=-c\mathrm{Log}(t)+K \qquad (29m)$$

With the initial condition $v(t_E)=C$, we obtain the constant K and we finally we get:

$$v(t)=-c\mathrm{Log}\,(t/t_E)+C \qquad (29n)$$

Consequently, the photon reaches O (with $v(t_0)=0$) at time $t_0$ with:

$$t_0/t_E=\exp\,(C/c) \qquad (29o)$$

$t_E$ represents the lowest age of the Universe that we can observe at the present age of the Universe $t_0$. Indeed, it is evident that if a photon is emitted from a galaxy at a time inferior to $t_E$, it will reach O before $t_0$, and consequently will be not observed at $t_0$. We remark that in the previous equation $t_0/t_E$ is equal to the factor of expansion $1+z_E$ of the Universe between the emission of the photon ($t_E$) and its reception in O ($t_0$) (according to the 1st model of CBE). We obtain an analogous expression if the photon is emitted at an absolute time $t_F$ of a commoving point driven with an absolute velocity $V_F$. We then have:

$$t_0/t_F=1+z_F=\exp(V_F/c)\leq\exp(C/c) \qquad (29p)$$

The previous relation permits also to obtain the lowest age of the Universe that can be observed.
We know that according to the SCM, it existed a dark age, finishing at an absolute age $t_D$, in which most of the Universe could not be observed. The existence of this dark age is clearly in agreement with the CBE, and consequently we will keep this hypothesis. Then the lowest age for which the Universe that can be observed is the greatest between $t_E$ and $t_D$ defined previously.
And consequently:

$$C\geq c\mathrm{Log}(1+z_F) \qquad (29q)$$

The second method permitting to get the previous relation, much simpler, would have been to use directly the equation (29g). $z_F$ can represent any observed redshift. Taking $z_F=10$ we obtain C>2,3c.

It is very possible that C be much greater than 2,3, for instance C=10. In that case, we could possibly observe the Universe when its age was only 1 million years .

### 2.8 Fossil radiation.

This section is valid for both models of the CBE.

In complete analogy with the SCM, we admit the apparition of a fossil radiation at an absolute time very close to the Big-Bang (whose the corresponding absolute time is equal to 0). Proceeding as in the SCM, because of the point 2. of the Introduction (PART I), we obtain in CBE that if the fossil radiation appears at an absolute time $t_{iR.F}$ corresponding to a temperature $T_{iR.F}$, then at an absolute time t superior to $t_{iR.F}$, if the factor of expansion between $t_{iR.F}$ and t is 1+z, then the fossil radiation at t corresponds to a temperature $T_{R.F}(t)=T_{iR.F}/(1+z)$. (This is obtained in CBE exactly the same way as in SCM, because we have in both Cosmological models that with the same notations the density of photons is divided by $(1+z)^3$ and the lengths of wave of photons are increased by a factor (1+z)). But we obtain also in CBE that the Referential in which fossil radiation is isotropic is the local Ether. This Referential was not interpreted in the SCM. So CBE is in agreement with the observation of fossil radiation corresponding with a high redshift z [(5)] . We then interpret heterogeneities of fossil radiation the same way as in SCM.

It is important to know what happens to a photon reaching the borders of the spherical Universe. It could be absorbed but it is not the only possible hypothesis. The simplest hypothesis would be that it be reflected, taking exactly the opposite of its local velocity (as a vector).

**2.9 2nd model of CBE.**

So we saw that the 1st model of the swelling balloon, despite of its great simplicity, is compatible with most of Cosmological observations. This 1st model uses very simple mathematics and is not based on General Relativity, contrary to the SCM. Nonetheless it is possible to present a 2nd model of CBE, based on General Relativity. Excepted the fact that we loose the very simple relation $1+z=t_0/t$, but a much more complicated expression, most of results valid for the 1st model remain valid in the 2nd model. This is due to the fact that the hypothesis A,B,C,D are valid for both models.

If $z(t_1,t_2)$ is the redshift of a photon between the ages of the Universe $t_1$ and $t_2$, then we have always as in the 1st model the factor of expansion $f(t_1,t_2)$ (because of the point 2. of 1.Introduction (PART I) that we justified previously):

$$1+z(t_1,t_2)=f(t_1,t_2) \qquad (29r)$$

So $f(t_1, t_2)$ is obtained in the 2nd model of CBE using the equations of general Relativity. (In the 1st model, $f(t_1,t_2)=t_2/t_1$). Then if $R(t_1)$ is the radius of the Universe at time $t_1$, and $t_2>t_1$, the expression of the radius $R(t_2)$ is:

$$R(t_2)=R(t_1)(1+z(t_1,t_2))=R(t_1)f(t_1,t_2) \qquad (29s)$$

So we obtain that at time $t_2$ the velocity of the borders of the Universe is ($t_1$ being a constant):

$$V(t_2)=\frac{d(R(t_2))}{dt_2}=R(t_1)\frac{d}{dt_2}(f(t_1,t_2)) \qquad (29t)$$

We define in the 2nd model of the CBE a commoving point of the swelling sphere exactly the same way as for the 1st model, as well the absolute Ether. (Hypothesis Da,b). We obtain consequently that if A(t) and B(t) are 2 commoving points and if f is the factor of expansion of the Universe between $t_1$ and $t_2$, then we have the relations:

$A(t_2)B(t_2)/A(t_1)B(t_1)=f$

$(A(t_2),B(t_2))//A(t_1)B(t_1)$ (29u)

As in the 1st model, we obtain that if A(t) is a commoving point belonging to a radius OP(t), V(t) being the velocity of P(t) (and also the velocity of the borders of the Universe), $V_A(t)$ being the absolute velocity of A at time t, we have a constant a such that:

$V_A(t)=aV(t).$ (29v)

In the 2nd model of the CBE, fossil radiation is interpreted exactly the same way as in the 1st model. In particular the Referential in which fossil radiation is isotropic is the local Ether. Dark energy can then be interpreted as the thermodynamic energy of the ether-substance that we modeled as an ideal gas. We remark that both model of the CBE are in contradiction with the SCM, in particular concerning the Cosmological Principle.

3.LOCAL ETHER AND ISOTROPY OF FOSSIL RADIATION

We remind that we interpreted the Referential in which fossil radiation was isotropic as a local Ether. We also know that in the SCM, we have the following temperature fluctuations for fossil radiation:

$$(\frac{\Delta T}{T}) = \frac{1}{4\pi}\sum_l l(2l+1)C_l \qquad (30)$$

In the previous expression l=1 is the dipole contribution, corresponding to the motion of the earth relative to the Referential in which fossil radiation is isotropic. So in CBE, we keep the equation (30), and we can interpret the dipole contribution of this equation.

4.CONCLUSION (PART I)

So we see that the existence of ***local Ethers*** and ***ether-substance*** introduced and defined in the hypothesis A, B, C,D appears to be fundamental in order to interpret fossil radiation, the dark matter and the topology of the Universe. We saw that those 2 kinds of ether could be detected experimentally, the 1st one by the observation of fossil radiation and the 2nd one by the observation of its interaction with gravitation (rotation curve of galaxies). It is very remarkable that the 3 admitted fundamental points 1,2,3 of CBE not only are compatible with the SCM, but also are consequences of hypothesis A,B,C,D. We have also seen that CBE is compatible with Special and General Relativity, even if the latter was not used in the 1st model of the CBE, model that is mathematically and physically much simpler than the SCM. We also interpreted the flat rotation curve of galaxies and Tully-Fisher's law. We have also seen that in the 1st model of the CBE, we could obtain in a very simple way, without using the complex mathematics of General Relativity, Hubble's constant and cosmological distances in agreement with observation. We also saw that the Cosmological Principle was not valid in the CBE, contrary to SCM, but that the Universe was observed as isotropic in CBE if the observer was situated sufficiently far from the borders of the Universe. We have also seen that in CBE, the topology of the Universe flat and spherical, was much simpler than in the SCM. In this last model, the topological model of the Universe can be plane, spherical or as a horse's saddle, but those models are “surfacic” models, in which the Cosmological Principle is valid. Moreover, an infinity of topological models are valid.

PART II

In PART I of this article , we presented a new Cosmology, called Cosmology based on Ether (CBE). In this $2^{nd}$ part, we complete this Cosmology, studying the motion of a spherical concentration of ether-substance (constituting many galaxies according to the preceding article), the thermal effects of this motion, between the spherical concentration and the intergalactic ether-substance, and the effects of this motion on the mass of the spherical concentration. We will see that it exists 2 kinds of radius in a galaxy, the $1^{st}$ one being the baryonic radius (visible) and the $2^{nd}$ being the radius of the spherical concentration of ether-substance. We will give the mathematical expression of this $2^{nd}$ kind of radius, and we will study a particular case, the case of the milky way at an age of the universe of 5 billion years. We will also study the concentration of ether-substance around stars and planets, and we will make appear the existence of new kinds of galaxies.

## 1.INTRODUCTION (PART II)

In the PART I of this article, we exposed a very general Cosmology based on ether (CBE). We have seen in this article that in some cases a spiral galaxy could be modeled as a spherical concentration of ether-substance, substance filling the Universe and constituting what is called (wrongly) “the vacuum”. This spherical concentration moving through the intergalactic ether-substance, we could expect that this motion involves a modification of the mass and of the velocity of the galaxy. So we are going to study this motion and also its thermal effects. Moreover we will see that it exists 2 kinds of radius in a galaxy: The $1^{st}$ kind is the radius of the spherical concentration of ether-substance constituting the galaxy, and for this reason it is called the *ethered radius* of the galaxy. The $2^{nd}$ kind of radius is the classical *baryonic radius* of the galaxy. We will study the evolution of the ethered radius as a function of the age of the Universe, and we will verifyy a simple relation that must exist between the 2 radius in the cas of the milky way. We will also study concentration of ether-substance around stars and planet and we will make appear the existence of new kinds of galaxies.

As in the preceding article, we will use the letters SCM for the “Standard Cosmological Model”, model presently admitted by most astrophysicists.

## 2.MOTION OF A GALAXY INSIDE THE INTERGALACTIC ETHER-SUBSTANCE

We could think that a spherical concentration of ether-substance constituting a galaxy, moving through the intergalactic ether-substance, is submitted to some modifications of its own mass and velocity because of this motion.

In fact, we have 2 phenomena that we are going to justify further:

a) The moving spherical concentration of ether-substance keeps its mass.

b) The moving spherical concentration of ether-substance keeps its velocity: It is not slowed down nor accelerated.

Indeed, let us consider a spherical concentration of ether-substance (center O) driven with a velocity **V** relative to the intergalactic ether-substance (locally). Let us consider the disk whose center is O, its radius is the radius of the spherical concentration of ether-substance, and that is perpendicular to **V**. Let S be the surface of the disk. Then in an interval of absolute time dt, we have the 2 phenomena:

c) A volume SVdt of ether-substance is absorbed by the spherical concentration.(In front of the sphere).
d) A volume SVdt is emitted by the spherical concentration (to the back of the sphere).

Moreover we remark that the emitted and the absorbed ether-substance have the same velocity and the same density. Consequently the emitted mass and the absorbed mass are equal (point a)). Moreover we can assume that the emitted and the absorbed ether-substance have the same velocity (velocity of the surrounding intergalactic ether-substance), and consequently the velocity of the spherical concentration is not modified (point b).
Then the points a) and b) appear to be consequences of the points c) and d) and of the last remark.

## 3.BARYONIC AND ETHERED RADIUS OF A GALAXY

We know that the galaxy Andromeda is approximately at 2.5 billions year-light of our galaxy the milky way. We consider for instance the case of the milky way in order to study the 2 kinds of radius of a galaxy.

We saw in the previous article that if r is the distance to the center O of a spherical concentration of ether-substance constituting a galaxy, then the expression of the density of ether-substance $\rho(r)$ is, $k_3$ being a constant:

$$\rho(r) = \frac{k_3}{r^2} \qquad (31)$$

So we obtain, M being the mass of the sphere having its center in O and a radius r:

$$M(r)=4\pi k_3 r \qquad (32)$$

Consequently, v being the velocity of a star at a distance r of O:

$$v^2 = \frac{GM}{r} = 4\pi k_3 G \qquad (33)$$

Consequently:

$$k_3 = \frac{v^2}{4\pi G} \qquad (34)$$

We know also that if $\rho_0$ is the local density of the intergalactic ether-substance surrounding the spherical concentration of ether-substance, then the radius R of this concentration of ether-substance constituting the galaxy is given by the expression:

$$\rho(R) = \frac{k_3}{R^2} = \rho_0 \qquad (35)$$

Consequently:

$$R = \sqrt{\frac{k_3}{\rho_0}} = v\sqrt{\frac{1}{4\pi G\rho_0}} \qquad (36)$$

We will call R the *ethered radius* of the considered galaxy.

Let $\rho_0(5)$ be the density of the intergalactic ether-substance when the age of the universe was 5 billion years, and $\rho_0(15)$ at an age of 15 billion years (meaning presently).

We know, with the model of the swelling sphere exposed in the PART I of this article , that if f is the factor of expansion of the universe between 5 and 15 billion years, the total mass of the ether-substance remaining the same and the volume of the Universe increasing by a factor $f^3$, the density of the ether-susbstance being the same in all the Universe:

$\rho_0(15)=\rho_0(5)/f^3$ (37)

Moreover according to the 1st model of the CBE, f=15/5=3 in our case.

So in a galaxy for which it exists a spherical concentration of ether-substance with a density in $1/r^2$, we have 2 different kinds of radius:

The 1st kind of radius, called *ethered radius*, is the radius of the spherical concentration of ether-substance. The 2nd kind of radius is the radius of the smallest sphere containing all the stars. We will call *baryonic radius* this second kind of radius. We remark that at a given time, the ethered radius must be greater than the baryonic radius.

We can define $r_B(15)$ as the present baryonic radius of the milky way. We know that $r_B(15)$ is approximately equal to 50000 years light . If R(15) is the present ethered radius of the milky way, let us suppose that R(15) is approximately 10 times greater than $r_B(15)$ (approximately 500000 light-years):

$R(15)\approx10r_B(15)$ (38)

Of course we ignore the real value of R(15),we can only know its minimal value (It must be superior to the baryonic radius). We are going to see that our hypothesis (8) leads to coherent results. Let $r_B(5)$ be the baryonic radius of the milky way when the age of the Universe was 5 billion years. Considering that the baryonic radius increases with time, we have the relation:

$r_B(15)\geq r_B(5)$ (39)

We have seen and justified theoretically in the PART I of this article that according to the baryonic Tully-Fisher's law the velocity of stars in a galaxy with a flat rotation curve depended only on its baryonic mass. Consequently if we suppose that between 5 and 15 billion years, the baryonic mass of the galaxy remained approximately the same, the velocity v used in the equation (36) remains unchanged between 5 and 15 billion years. Using this equation (36) and the equation (37), taking f=3 and $\sqrt{(27)}\approx5$, we obtain, R(5) being the ethered radius of the milky way at an age of the Universe equal to 5 billion years:

$R(5)\approx R(15)/5\approx2r_B(15)$ (40)

Using the equations (39) and (40) we obtain that at an age of the Universe of 5 billion years, the ethered radius was greater than the baryonic radius:

$r_B(5)\leq R(5)$ (41)

We remark that the previous relation (41) would remain true for a galaxy with the same ethered radius R'(15)=500000 light-years but with a baryonic radius $r'_B(15)$ twice greater than the radius of the milky way meaning 100000 light-years. (We just take $r'_B(15) \approx$ 100000 years light and replace the equation (38) by the equation: $R'(15)\approx5r'_B(15)$).

## 4.THERMAL TRANSFER TO A MOVING GALAXY

We remark that the phenomenon of absorption and of emission of ether-substance by a galaxy that we described in the Section 2 of this PART II modifies the thermal equilibrium that we used in the PART I of this article in order to obtain the Tully-Fisher's law. Indeed the absorbed ether-substance (cold) is not at the same temperature than the lost ether-substance (hot).

Nonetheless we can consider that the absorption and the emission of ether-substance by a galaxy leads to a power $\varepsilon(t)$ dissipated by the spherical concentration of ether-substance. $\varepsilon(t)$ mainly depends on the ethered radius of the moving spherical concentration, of its velocity relative to the local intergalactic ether-substance, of the density of the intergalactic ether-substance, and of the temperatures of the ether-substance.

If we make the approximation that $\varepsilon(t)$ is negligible compared with the power emitted by the baryons of a galaxy towards the spherical concentration of ether-substance (whose we supposed the existence in order to obtain Tully-Fisher's law), then our thermal model remains valid with a very good approximation. We can a priori neglect $\varepsilon(t)$ because the velocity of the spherical concentration of ether-substance, that is of the order of 300km/s, is very low relative to the ethered radius of the considered galaxies (At least of the order of 100000 light-years).

## 5.CONCENTRATION OF ETHER-SUBSTANCE AROUND STARS AND PLANETS

It is natural to assume that because of gravitation, there is a concentration of ether-substance occurs around planets and stars.

Let us for instance consider a star with a mass M. The same way as for galaxies with a flat rotation curve, we can assume that there is a concentration of ether-substance around the star, in equilibrium at a given temperature T.

The equation of equilibrium is, for an element of ether-substance with a density $\rho(r)$, a width dr, a surface dS situated at a distance r from O the center of the sun, P(r) being the pressure at this distance of O, assuming that r is greater than the baryonic radius R of the star, neglecting the gravitational attraction due to the sphere of ether-substance having r as radius :

$$P(r+dr)dS - P(r)dS + \frac{GM\rho(r)drdS}{r^2} = 0 \qquad (42)$$

We remind (Equation (2)) that we have $P(r)=k_1\rho(r)$ with $k_1=k_0T$, T temperature of the concentration of ether-substance.
So we obtain, solving easily the previous differential equation:

$$\rho(r) = K\exp(\frac{GM}{k_1 r}) \qquad (43)$$

If $\rho_0$ is the density of ether-substance surrounding the concentration of ether-substance around the star ($\rho_0$ is not generally the density of the intergalactic ether-substance contrary to the galaxies that we studied. It is very often the density of the spherical concentration of ether-substance constituting the galaxy to which the star belongs), a 1st hypothesis is $K=\rho_0$. Then we have:
It is possible, but not certain, that as in our model of spiral galaxies, the concentration of ether-substance around the mass M be at a different temperature from the temperature of the galaxies between stars.

It seems to be logical to assume in a first model that if $\rho_0$ is the density of the ether-substance surrounding the concentration of ether-substance linked to the sun, $K=\rho_0$. So we have:

$$\rho(r) = \rho_0 \exp(\frac{GM}{k_1 r}) \qquad (44)$$

This model leads to incoherencies ($\rho(r)$ too great)

A second possible model is the following one. Let us suppose that R is the radius of the considered star, $R_S$ being the radius of the concentration of ether-substance around the star: Then we can assume $R_S$=R. with $\rho(R)=\rho_0$. Then the equation (43) leads then to densities inferior to $\rho_0$. for r>R. But this is acceptable as in the case of galaxies studied in PART I with a density of ether-substance in $1/r^2$ for which the predicted density was inferior to $\rho_0$ for r>$R_S$. We can then evaluate T the same way as for galaxies that we studied in PART I. We obtain $\rho(r)$ for r<R using a new equilibrium equation, in which we can consider only the attraction of the baryonic mass of the star. This second model can also be valid for some galaxies. 2 particular limit cases for galaxies are possible: We know that in absence of baryonic particles, a constant density equal to $\rho_0$ defines a state of equilibrium. So in the first limit case, it could be possible that the baryonic gravitation due to a galaxy induces just a perturbation of this state of equilibrium. Then $\rho(r)$ is very close to $\rho_0$, but we cannot anymore neglect the attraction due to ether-substance in the equation of equilibrium for r<R. In the second limit case we can, as for stars, neglect the attraction of ether-substance in the equation of equilibrium for r<R. So we consider only the gravitational attraction due to the baryonic mass of the galaxy.

In a third model, there is no concentration of ether-substance on the star, the ether-substance around the star possesses a density $\rho(r)=\rho_0$, there is no equation of equilibrium giving $\rho(r)$ and the temperature of the ether-substance around the star is the temperature of the surrounding ether-substance. As in the second model, this is justified if we find for r<R a density inferior to $\rho_0$ in the second model. There is also a second more general (including the 1st one) justification: We can admit that naturally the ether-substance tends to be homogeneous in density and temperature. This is a consequence of this effect that the intergalactic ether-substance is homogeneous in density and temperature. Let us call *homogenization effect* this effect. We can consider that in the case of spherical concentrations with densities of ether-substance in $1/r^2$ that we studied, the gravitational effect canceled the homogenization effect for r<R, but when r>R it was the contrary. So it is natural to assume that in some case of galaxies (or stars) the homogenization effect predominated and in that case we have $\rho(r)=\rho_0$.

So we see that we have new kinds of galaxies, with among them some galaxies with density of ether-substance equal or close to $\rho_0$, $\rho_0$ being the density of ether-substance in which they are immerged. $\rho_0$ can be the density of intergalactic ether-substance, but not always, for instance when the considered galaxy is a satellite of a galaxy presenting a spherical concentration of ether-substance in $1/r^2$.

We can suppose that the galaxies that are satellites of the milky way, as for instance the Large Magellanic cloud, correspond to those new kinds of galaxies. We remind that those galaxies have a velocity close to the velocities of the stars of the milky way, and consequently we can deduce that the ethered radius of the milky way (see previous section) is superior to the distance between those galaxies satellites and the center of the milky way. We recall that some models without dark matter exist for those galaxies [12] .

We remind that we justified in the 1st section of this PART II that a moving spherical concentration of ether-substance inside the surrounding ether-substance (for instance in the case of a galaxy) kept its mass and was not slowed down nor accelerated. We have a second possible justification:

Let us suppose that the moving spherical concentration of ether-substance expels a little more ether-substance than it absorbs. Let us suppose for instance that the difference is $\delta m$. Then the equation of equilibrium remaining the same, we can assume that the spherical concentration of ether-substance will gain also the missing mass $\delta m$. Consequently the mass of the concentration of ether-substance remains the same. Moreover $\delta m$ is absorbed from the surrounding ether-substance. Consequently the balance between the absorbed and the expelled surrounding ether-substance is equal to 0. Moreover we can assume that expelled and absorbed ether-substance have the same velocity (velocity of the surrounding intergalactic ether-substance). Consequently, this is a second and more general justification that the spherical concentration of ether-substance is not accelerated nor slowed down.

We remind that in the PART I of our article, we made the hypothesis that the baryons transmitted some energy to the ether-substance surrounding them only if their temperature was superior. It is also possible that baryons transmit some energy to the ether-substance in which they are immerged even if their temperature is inferior. We can justify this by the following argument:
We can admit that a baryon vibrates if it is at any temperature (The more it vibrates the higher is its temperature). Then the ether-substance surrounding the baryon slows down this vibration and consequently baryons communicate, whatever be their temperature, an energy to this ether-substance that is converted in thermal energy.

## 6.TEMPERATURE OF THE INTERGALACTIC ETHER-SUBSTANCE

In the PART I of our article, we have seen that according to CBE, the Universe was a sphere filled of ether-substance, surrounded by a medium called “nothingness”. We saw that we could model a convective transfer between this spherical Universe and the nothingness. The convective flow F was then in agreement with the expression $F=kT(t)$, $T(t)$ being the temperature of the intergalactic ether-substance at an age of the Universe t. It is easy to verify that it is impossible that we have a constant C’ such than $k=C'\rho_0$, contrary to the case in which we had also a convective transfer but between 2 mediums of ether-substance. It is nonetheless possible that k be constant, independent of the density of the intergalactic ether-substance. Then in this case, because of the equation of thermal equilibrium $KM=4\pi R(t)^2(kT(t))$, with K constant, M baryonic mass of the Universe, R(t) radius of the Universe at an age t, we obtain that T(t) evoluates in $1/(1+z)^2$, (1+z) factor of expansion of the Universe. Supposing that at the time in which fossil radiation was emitted, corresponding to a redshift z of the order of 1500, the temperature of the intergalactic ether-substance was equal to the temperature of fossil radiation, we obtain that presently (with an age of the Universe of 15 billion years), the temperature of the intergalactic ether-substance is 1500 times lower than the temperature of fossil radiation., which is an acceptable value, justifying our approximation that the temperature of the intergalactic ether-substance can be neglected in comparison with the temperature of spherical concentrations of ether-substance (corresponding to galaxies with flat rotation curve, see PART I).

## 7.CONCLUSION (PART II)

So we justified that the motion of a spherical concentration of ether in the intergalactic space did not modify its mass nor its velocity. Moreover we defined 2 different radius for a galaxy, the ethered radius and the baryonic radius. We verified in the case of the milky way that the ethered radius must be greater that the baryonic radius at a given age of the Universe. We also established the evolution as a function of time of the ethered radius. We also made an important approximation in the thermal model permitting to obtain the Tully-Fisher's law. To end we also studied concentrations of ether-substance around stars, planets and some kinds of galaxies.

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