Theory of the dynamic medium of reference: Exterior case and interior case

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Abstract: The theory of the dynamic medium of reference (DMR) has already been presented in several articles by this author [O. Pignard, Phys. Essays **32**, 422 (2019); **33**, 395 (2020); **34**, 61 (2021)], and in particular, in the first one titled "Dynamic medium of reference: A new theory of gravitation." This theory proposes the existence of a medium made up of entities called gravitons. A gravitational field is a flux of the medium, whose speed is defined by the formula $\overrightarrow{C_{G/R}}(M) = \frac{\sum_{i=1}^{N_G}\overrightarrow{V_{G/R}}}{N_G} = \overrightarrow{V_{\text{flux}}}(M)$, where $\overrightarrow{V_{G/R}}$ is the speed of the gravitons with regard to the reference frame R and N_G is the number of gravitons contained in an elementary volume centered in M. A massive body of mass M creates a flux of the medium of acceleration $\overrightarrow{\gamma_{\text{flux}}} = -(GM/r^2)\overrightarrow{u_r}$ and speed $\overrightarrow{V_{\text{flux}}} = -\sqrt{(2GM/r)}\overrightarrow{u_r}$, both centripetal. While the relationship between the acceleration and the speed of the flux of the medium has already been demonstrated, the formula of the acceleration has not yet been demonstrated. This article proposes to provide the demonstration of the formula of acceleration in the exterior case (point M outside the massive body creating the gravitational field) and in the interior case (point M inside the massive body creating the gravitational field). It is then given the link between the theory of the DMR and general relativity in the exterior case and the interior case. Finally, the article presents reflections between the two theories and then gives arguments in favor of a propagation speed of the gravitational field much greater than that of light, noting that the theory of the DMR establishes a difference between the gravitational fields, which propagate at the speed of the gravitons and gravitational waves, which propagate at the speed of light.
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Résumé: La théorie du Milieu Dynamique de Référence a déjà été présentée dans plusieurs articles de cet auteur [Phys. Essays **32**, 422 (2019); **33**, 395 (2020); **34**, 61 (2021)], et en particulier dans le premier intitulé "Dynamic Medium of Reference: A new theory of gravitation". Cette théorie propose l'existence d'un milieu constitué d'entités appelées gravitons. Un champ gravitationnel est un **flux du milieu** dont la vitesse est définie par la formule $\overrightarrow{C_{G/R}}(M) = \frac{\sum_{i=1}^{N_G}\overrightarrow{V_{G/R}}}{N_G} = \overrightarrow{V_{\text{flux}}}(M)$ où $\overrightarrow{V_{G/R}}$ est la vitesse des gravitons par rapport au référentiel R et N_G est le nombre de gravitons contenus dans un volume élémentaire centré en M. Un corps massif de masse M crée un flux du milieu d'accélération $\overrightarrow{\gamma_{\text{flux}}} = -\frac{GM}{r^2}\overrightarrow{u_r}$ et de vitesse $\overrightarrow{V_{\text{flux}}} = -\sqrt{\frac{2GM}{r}}\overrightarrow{u_r}$ toutes les deux centripètes. Alors que la relation entre l'accélération et la vitesse du flux du milieu a déjà été démontrée, la formule de l'accélération n'a pas encore été démontrée. Cet article se propose de fournir la démonstration de la formule de l'accélération dans le cas extérieur (point M à l'extérieur du corps massif créant le champ gravitationnel) et dans le cas intérieur (point M à l'intérieur du corps massif créant le champ gravitationnel). Il est ensuite donné le lien entre la théorie du Milieu Dynamique de Référence et la Relativité Générale dans le cas extérieur et le cas intérieur. Enfin, l'article présente des réflexions entre les deux théories puis donne des arguments en faveur d'une vitesse de propagation du champ gravitationnel bien supérieure à celle de la lumière, tout en précisant que la théorie du Milieu Dynamique de Référence établit une différence entre les champs gravitationnels qui se propagent à la vitesse des gravitons et les ondes gravitationnelles qui se propagent à la vitesse de la lumière.

Key words: Gravitation; Dynamic Medium of Reference; Gravitons Field; Exterior Case; Interior Case; Flux of the Medium.

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I. SUCCINCT PRESENTATION OF THE THEORY OF THE DYNAMIC MEDIUM OF REFERENCE

Important preliminary remark:

This article does not present the theory of the dynamic medium of reference (DMR).

To do this, refer to the article "Dynamic medium of reference: A new theory of gravitation,"[1] which it is strongly recommended to have read in order to understand this article.

This article presents only a demonstration of the acceleration and velocity of the flux of the medium in the exterior case and the interior case.

The theory of the DMR[1] introduces a dynamic nonmaterial medium, which is present in the whole Universe.

The characteristics of this medium are:

- This medium enables one to deduce a Preferred Frame of Reference or rather a REFERENCE in the whole Universe and at all scales.
- This REFERENCE enables one to obtain a privileged time. The present moment is universal, that is to say the same in the whole Universe.
- This medium is also the medium of propagation of light.
- This medium verifies the principle of reciprocal action:
  - The medium is distorted by matter and energy like the space-time of general relativity.
  - The warping of this medium determines the trajectories of the particles (material particles and light particles).

The presence of a massive body creates a flux of the medium (centripetal that is to say, directed toward the center of gravity of the massive body) of speed

$$V_{\text{flux}} = \sqrt{\frac{2\text{GM}}{r}} \tag{1}$$

and acceleration

$$\gamma_{\text{flux}} = \frac{\text{GM}}{r^2}, \tag{2}$$

where r refers to the distance to the center of gravity of the massive body.

In the framework of the Lorentz/Poincaré theory, in the absence of a gravitational field, material clocks (in the reference frame R) undergo a physical dilatation of their period according to their speed with respect to the Preferred Frame of Reference (PFR) according to the formula

$$T = \gamma.T_0 \quad \text{with} \quad \gamma = \left(1 - \frac{V_{R/\text{PFR}}^2}{c^2}\right)^{-1/2}. \tag{3}$$

Within the framework of the Lorentz/Poincaré theory, in the absence of a gravitational field, material rulers (in the reference frame R) undergo a physical contraction of their length according to their speed with respect to the Preferred Frame of Reference (PFR) according to the formula

$$L = \frac{L_0}{\gamma} \quad \text{with} \quad \gamma = \left(1 - \frac{V_{R/\text{PFR}}^2}{c^2}\right)^{-1/2}. \tag{4}$$

In the presence of a massive body of mass M, the speed of the flux of the medium takes the following expression in the frame of reference linked to the massive body and at a distance r from the center of gravity of the massive body[1]

$$\overrightarrow{V_{\text{flux}}} = -\sqrt{\frac{2\text{GM}}{r}}\overrightarrow{u_r}, \tag{5}$$

where $\overrightarrow{u_r}$ denotes the unit radial vector directed toward the exterior of the massive body.

The effects undergone by material clocks and rulers due to their speed with respect to the medium (which allows to define the Preferred Frame of Reference) are the same as the effects they undergo by the centripetal movement of the medium due to a massive body. Since clocks and rulers are assumed to be fixed with respect to the massive body, the centripetal movement of the medium (of speed V_{flux}) with respect to the center of gravity of the massive body can be interpreted as a movement of the clocks and rulers with respect to the medium.

The equivalence between the movement of the clocks and rulers with respect to the medium and the movement of the medium with respect to the clocks and rulers is a new way of stating the principle of equivalence.

In the presence of a massive body of mass M, material clocks undergo a physical dilatation of their period according to the following formula:[1]

$$T = T_0.K(r) \quad \text{with} \quad K(r) = \left(1 - \frac{V_{\text{flux}}^2}{c_0^2}\right)^{-1/2} = \left(1 - \frac{2\text{GM}}{c_0^2.r}\right)^{-1/2}. \tag{6}$$

In the presence of a massive body of mass M, material rulers undergo a physical contraction of their length according to the following formula:[1]

$$L = \frac{L_0}{K(r)} \quad \text{with} \quad K(r) = \left(1 - \frac{V_{\text{flux}}^2}{c_0^2}\right)^{-1/2} = \left(1 - \frac{2\text{GM}}{c_0^2.r}\right)^{-1/2}. \tag{7}$$

Light is slowed down by a gravitational field, and the expression of its speed is[1]

$$c = \frac{c_0}{K\sqrt{1 + (K^2 - 1)\cos^2\beta}}. \tag{8}$$

We name $\beta = \left(\overrightarrow{u_r}, \overrightarrow{c}\right)$ the angle between the unit radial vector $\overrightarrow{u_r}$ and the speed vector of light $\overrightarrow{c}$. The vector $\overrightarrow{c_0}$ represents the speed vector of light if there was not any massive body.

In the case of a radial trajectory of the light, we have the following simple expression:

$$c = \frac{c_0}{n(r)} = \frac{c_0}{K^2(r)}. \tag{9}$$

If we call ε_0 the permittivity and μ_0 the permeability of the medium without gravitational field, then we have $c_0 = (\varepsilon_0\mu_0)^{-1/2}$.

If we call ε the permittivity and μ the permeability of the medium in the presence of a gravitational field created by a massive body of mass M, then we have $c = (\varepsilon\mu)^{-1/2}$ with

$$\varepsilon = \varepsilon_0.\varepsilon_r = \varepsilon_0\left(1 - \frac{2GM}{c_0^2 r}\right)^{-1} \quad (10)$$

and

$$\mu = \mu_0.\mu_r = \mu_0\left(1 - \frac{2GM}{c_0^2 r}\right)^{-1}. \quad (11)$$

The refractive index is given by the formula

$$n = \sqrt{\varepsilon_r \mu_r} = \left(1 - \frac{2GM}{c_0^2 r}\right)^{-1}, \quad (12)$$

with

$$\varepsilon_r = \varepsilon/\varepsilon_0 = \left(1 - \frac{2GM}{c_0^2 r}\right)^{-1} \quad (13)$$

and

$$\mu_r = \frac{\mu}{\mu_0} = \left(1 - \frac{2GM}{c_0^2 r}\right)^{-1}. \quad (14)$$

All these formulas show that the medium is related to electricity, magnetism, electromagnetism, and gravitation.

(a) Case of the photon
The exploitation of the previous results makes it possible to establish the Lagrangian formulation of the trajectory of a photon[1]

$$L = K^2\left[c_0^2 - \left(K^2\frac{dr}{dt}\right)^2 - \left(Kr\frac{d\varphi}{dt}\right)^2\right] = 0, \quad (15)$$

$$\left(K^2\frac{dr}{dt}\right)^2 + \left(Kr\frac{d\varphi}{dt}\right)^2 = c_0^2. \quad (16)$$

After the development of calculations, we end up with the following equation:[1]

$$\frac{d^2u}{d\phi^2} + u = \frac{3GM}{c^2}u^2. \quad (17)$$

This equation makes it possible to determine the deflection of light rays by a massive body, for example, the Sun, and also by clusters of galaxies (gravitational lens, gravitational mirage, and Einstein ring).

(b) Case of a material particle
The exploitation of the previous results makes it possible to establish the Lagrangian formulation of the trajectory of a material particle[1]

$$c_0^2 - L = K^2\left[\left(K^2\frac{dr}{dt}\right)^2 + \left(Kr\frac{d\phi}{dt}\right)^2 - \frac{2GM}{r} - C^2\right] = 0, \quad (18)$$

that we can write

$$\left(K^2\frac{dr}{dt}\right)^2 + \left(Kr\frac{d\phi}{dt}\right)^2 = \frac{2GM}{r} + C^2 = V_{\text{flux}}^2 + C^2. \quad (19)$$

After the development of calculations, we end up with the following equation:[1]

$$\frac{d^2u}{d\varphi^2} + u = \frac{GM}{A^2} + \frac{3GM}{c^2}u^2. \quad (20)$$

This equation makes it possible to determine the trajectory of the planets of the solar system and, in particular, the precession of the perihelion of Mercury.

II. A POSSIBLE DESCRIPTION OF THE DMR: THE GRAVITONS FIELD

This part gives a possible description of the DMR: the gravitons field.

The gravitons field is based on the Le Sage theory, BUT it adds many deep changes and evolutions.

Numerous scientists have studied the Le Sage theory. Just to mention a few of them:

Newton, Huygens, Leibniz, Euler, Laplace, Lord Kelvin, Maxwell, Lorentz, Hilbert, Darwin, Poincaré and Feynman.

Henri Poincaré has studied this theory and written a synthesis in *Science et* Méthode.[2]

Poincaré sums up the principle of Le Sage theory like this:

> "It is proper to establish a parallel between these considerations and a theory proposed a long time ago in order to explain the universal gravitation. Let us suppose that, in the interplanetary spaces, very tiny particles move in all directions, with very high speeds. A single body in the space will not be affected, apparently, by the impact of these corpuscles, since these impacts are equally divided in all directions. But, if two bodies A and B are in the space, the body B will play the role of a screen and will intercept a part of these corpuscles which would have hit A. Then, the impacts received by A in the opposite direction of the one of B, will not have compensation any longer, or will be imperfectly compensated, and they will push A towards B. Such is Le Sage theory."

It is possible to demonstrate rather easily that the "push" is inversely proportional to the square distance between the two bodies (like the Newton law).

One can also demonstrate that, if the corpuscles are very tiny, the push is approximately proportional to the number of nucleons and so the mass of the body and not the apparent surface of the body.

Moreover, only a tiny fraction of corpuscles hits the atoms of the body, which explains that the push (the gravitational force) is so weak.

The main evolutions of the gravitons field versus the Le Sage theory are the following:

- One must not use the notion of impact between the corpuscles and matter.
- One must consider that the corpuscles are **nonmaterial** and constitute a **medium**.
- The total energy of an entity is the sum of its kinetic energy of translation and of its kinetic energy of rotation about itself.
- Fundamental law: Conservation of the total energy of an entity : The total energy of one entity remains constant

$$E_{\text{total}} = E_{\text{translation}} + E_{\text{rotation}} = \text{constant}. \tag{21}$$

Afterwards I will call these entities **gravitons** (but these gravitons have nothing to do with the graviton of spin 2 of quantum mechanics).

If the total energy of the gravitons remains constant, then the gravitons do not give energy to the atoms of the Earth and so do not raise the temperature of the Earth contrary to the conclusion made by Poincaré[2] on the original theory of Le Sage.

It is postulated that the gravitons which interact with the atoms of a massive body lose some of their kinetic energy of **translation** which turns into kinetic energy of **rotation**.

The gravitons which interact with the atoms of a massive body lose a part of their translation speed and win some rotation speed and are called **gravitons-spin**.

So a massive body would be a huge "transformer" of "standard gravitons" in "gravitons-spin."

This physical phenomenon does not raise the temperature of a massive body, BUT it has an effect on the **medium**.

The medium undergoes a centripetal flux due to the presence of the massive body.

Indeed, let us consider a reference frame at the surface of the massive body and an elementary volume linked to it.

If one measures the speed vectors of all the gravitons in this elementary volume, the average of the speed vectors gives a resulting speed vector which is centripetal (because the gravitons-spin coming from the ground have a smallest translation speed than the standard gravitons coming from the sky).

It will be demonstrated in the next part of this article that the acceleration of the flux of the medium has the following expression $\overrightarrow{\gamma_{\text{flux}}} = -(\text{GM}/r^2)\overrightarrow{u_r}$, from which one can deduce that the centripetal speed of the flux of the medium at a distance r from the center of gravity of a massive body of mass M is equal to (measured in a reference frame R linked to the massive body)

$$\overrightarrow{C_{G/R}} = \frac{\sum_{i=1}^{N_G} \overrightarrow{V_{G/R}}}{N_G} = \overrightarrow{V_{\text{flux}}} = -\sqrt{\frac{2GM}{r}}\overrightarrow{u_r}. \tag{22}$$

Definition of the Preferred Frame of Reference based on the entities constituting the medium:

Let us consider a Galilean referential R (a laboratory) and an elementary volume linked to this referential.

In this very small volume, imagine that we can count the entities in it (gravitons) and we can also know the speed vector of each graviton $\overrightarrow{V_{G/R}}$.

Knowing this, it is possible to compute the vectorial average of the speed vectors of the gravitons: $\overrightarrow{C_{G/R}} = \sum_{i=1}^{N_G} \overrightarrow{V_{G/R}}/N_G$.

This resultant vector means that, at the center of this given elementary volume, the Preferred Frame of Reference moves at the speed $\overrightarrow{C_{G/R}}$ versus the referential R and that the referential R (the laboratory) moves at the speed $-\overrightarrow{C_{G/R}}$ versus the Preferred Frame of Reference (defined by the medium), i.e., versus the medium.

Another way to present the Preferred Frame of Reference (PFR) is to define it as the unique referential for which, at any point M in space, we have

$$\overrightarrow{C_{G/\text{PFR}}}(M) = \frac{\sum_{i=1}^{N_G} \overrightarrow{\text{V}_{G/\text{PFR}}}}{N_G} = \overrightarrow{0}. \tag{23}$$

Figure 1 shows the distortion of the medium due to the Earth.

The flux of the medium

- is generated by the presence of the matter of the Earth,
- is always centripetal, i.e., radial, oriented toward the center of gravity of the Earth,
- is maximum at the surface of the Earth and decreases when going away from the Earth,
- has a constant modulus on every sphere, whose center is the one of the Earth, and

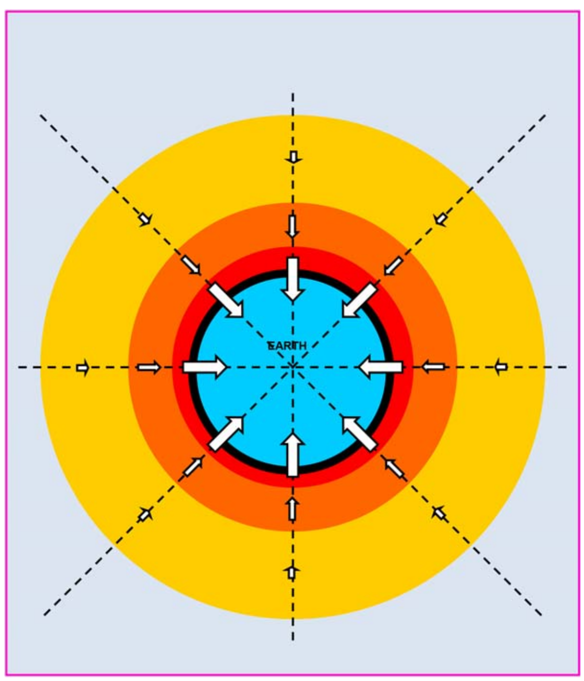

FIG. 1. (Color online) Distortion of the medium due to the Earth.

- gives the impression to follow the Earth in its movement (whatever its speed) because it remains identical to itself.

III. ACCELERATION AND VELOCITY OF THE FLUX OF THE MEDIUM

A. Acceleration of the flux of the medium in the exterior case

This part deals with obtaining the acceleration of the flux of the medium.

We want to determine the acceleration of the flux of the medium at a point M by taking into account the flux of gravitons arriving from all directions in space, and these directions being symbolized by elementary cones of elementary solid angle Ω_e and of section s_e at the distance r from point M. We then have the relation

$$\Omega_e = \frac{s_e}{r^2}. \tag{24}$$

An elementary cone is associated with one and only one direction of arrival of the incident gravitons at a given point M.

The number of elementary cones describing all directions of 3D space is

$$N_{c(3D)} = \frac{4\pi r^2}{s_e} = \frac{4\pi}{\Omega_e}. \tag{25}$$

The acceleration of the **flux of the medium** is given by the **vector average** of the flux of gravitons

$$\overrightarrow{\gamma_{\text{flux}}} = \frac{1}{N_{\text{tot}}} \sum_{i=1}^{N_{c(3D)}} F_i \overrightarrow{V_{Gi}}. \tag{26}$$

Here, $F_i = N_i/\Delta t$ is the flux of gravitons in a given direction, that is to say, the number of incident gravitons crossing the section of an elementary cone **per second** and moving toward the apex of the cone.

We also consider that the flux of gravitons is the same in all directions, therefore, in all elementary cones, we have

$$F_i = \frac{N_i}{\Delta t} = F_G = \frac{N_G}{\Delta t} = \text{constant}.$$

Regarding N_{tot} we have

$$N_{\text{tot}} = \sum_{i=1}^{N_{c(3D)}} N_i = N_G.N_{c(3D)} = \frac{4\pi N_G}{\Omega_e}. \tag{27}$$

1. Case of a thin plate

We will deal with the very simple case of a material plate of surface S_p and thickness e. We will further assume that the point M where we want to obtain the acceleration of the flux of the medium is very far from the center of gravity C of the plate and that the line MC is perpendicular to the surface of the plate so that all the contributions to be retained are along the MC axis.

The acceleration of the flux of the medium generated by the plate at a point M located at the distance r from the center of gravity of the plate has the formula

$$\overrightarrow{\gamma_{\text{flux}}} = \frac{1}{N_{\text{tot}}} \sum_{i=1}^{N_{c(3D)}} F_i \overrightarrow{V_{Gi}} = \frac{1}{N_{\text{tot}}} \frac{dN}{dt}.(V_{G\text{spin}} - V_G)\overrightarrow{u_r}\ , \tag{28}$$

$$\text{with } \frac{dN}{dt} = F_G.N_c.N_s.k_s.k_n, \tag{29}$$

where

- N_c is the number of elementary cones intercepted by the plate,
- N_s is the number of elementary slices of thickness the interatomic distance d contained in the thickness e of the plate,
- k_s is the proportion of gravitons for which an atom nucleus is in their path. So k_s is the ratio of the cross section of the nucleons constituting the nucleus of an atom and the square of the interatomic distance d.
- k_n is the proportion of gravitons having encountered an atom nucleus which have interacted with the nucleus and reemitted in the form of gravitons-spin. 1-k_n is the proportion of gravitons having encountered an atom nucleus and not having interacted with this atom nucleus,
- V_G is the speed of the incident gravitons, and
- V_{Gspin} is the speed of the gravitons-spin re-emitted by the nuclei of the atoms of the plate.

Demonstration of the above formula:

We will make two preliminary remarks to begin with:

- Incident gravitons which interact with an atom do not necessarily keep their incident direction. However, the material plate is made up of a very large number of atoms and it is assumed that, statistically, the gravitons-spin are re-emitted equally in all directions of space. We recall that the total number of incident gravitons arriving on the plate is equal to the total number of gravitons ("standard" gravitons and gravitons-spin) leaving the plate.
- Certain incident gravitons interact with several atoms of the plate. It is considered that this is counted in the velocity V_{Gspin}, which is in fact an average of the velocities of all the gravitons-spin having interacted with one or more atoms of the plate.

To establish the expression of the acceleration of the flux of the medium, which is a vector average of the flux of gravitons arriving from all directions in space, we must keep in mind that the vast majority of the fluxes of gravitons compensate each other:

- The gravitons arriving by the cones of the half-space where the plate is located, but without counting the cones intercepting the plate, will all be compensated by the gravitons arriving from the opposite cones with regard to the point M.

- The gravitons arriving through the cones intercepting the plate, but not interacting with the atoms of the plate, will all be compensated by the equivalent number of gravitons arriving from the opposite cones with regard to the point M.
- Only the gravitons arriving by the cones intercepting the plate and which interact with the atoms of the plate are not compensated. An equivalent number of gravitons-spin will leave the plate in the same cones intercepting the plate (seen from point M). We will have to compare the fluxes of these gravitons-spin with the fluxes of standard gravitons counted in equivalent number arriving from the opposite cones with regard to the point M.

We can therefore write

$$\overrightarrow{\gamma_{\text{flux}}} = (\gamma_1 - \gamma_2)\overrightarrow{u_r},$$

with

- $\gamma_1 = \frac{1}{N_{\text{tot}}} F_G.N_c.N_s.k_s.k_n.V_{\text{Gspin}}$ is the acceleration due to the gravitons-spin coming from the cones intercepting the plate. The number N of these gravitons-spin is equivalent to the number N of incident gravitons arriving from the cones intercepting the plate and having interacted with the atom nuclei of the plate.
- $\gamma_2 = \frac{1}{N_{\text{tot}}} F_G.N_c.N_s.k_s.k_n.V_G$ is the acceleration due to the gravitons arriving from the cones opposite to those intercepting the plate with regard to the point M and of the same number N as the incident gravitons arriving from the cones intercepting the plate and having interacted with the atom nuclei of the plate

whence
$$\overrightarrow{\gamma_{\text{flux}}} = (\gamma_1 - \gamma_2)\overrightarrow{u_r} = \frac{1}{N_{\text{tot}}} F_G.N_c.N_s.k_s.k_n.(V_{\text{Gspin}} - V_G)\overrightarrow{u_r}. \quad (30)$$

The number of elementary cones intercepted by the surface of the plate S_p is

$$N_c = \frac{S_p}{s_e} = \frac{S_p}{\Omega_e.r^2}. \quad (31)$$

The number of slices of thickness that the interatomic distance d contained in the thickness e of the plate is given by the following formula:

$$N_s = \frac{e}{d}. \quad (32)$$

The ratio of the cross section of the nucleons constituting the nucleus of an atom and the interatomic section can be written

$$k_s = \frac{N_n.s_n}{d^2}, \quad (33)$$

where

- s_n is the section of a nucleon,
- N_n is the number of nucleons in a given atomic nucleus, and
- d is the interatomic distance (of the order of an Angstrom).

We can write the modulus of the acceleration of the flux of the medium as

$$\gamma_{\text{flux}} = \frac{1}{N_{\text{tot}}} F_G.k_n.(V_G - V_{\text{Gspin}}).\frac{S_p}{\Omega_e.r^2}.\frac{e}{d}.\frac{N_n.s_n}{d^2}.$$

By setting $V = S_p.e$, the volume of the plate, ρ, the density of the plate, and M, the mass of the plate, we have $\rho = M/V = M/S_p.e$. We also have $\rho = N_n m_n/d^3$ where m_n is the mass of a nucleon.

Finally, thanks to the relation $S_p.e/d^3 = M/N_n m_n$, we can write the acceleration of the flux of the medium in the form

$$\gamma_{\text{flux}} = G\frac{M}{r^2}, \quad \text{where} \quad G = \frac{1}{N_{\text{tot}}}\frac{F_G}{\Omega_e} k_n \frac{s_n}{m_n}(V_G - V_{\text{Gspin}}). \quad (34)$$

In the theory of the DMR, the acceleration of the flux of the medium IS the gravitational acceleration and we therefore find Newton's well-known formula.

Finally using $N_{\text{tot}} = \frac{4\pi N_G}{\Omega_e}$ we have

$$G = \frac{k_n}{4\pi.\Delta t}\frac{s_n}{m_n}(V_G - V_{\text{Gspin}}). \quad (35)$$

This calculation has, above all, made it possible to find a formula for the gravitational constant as a function of the characteristics of the flux of gravitons.

Checking the unit of G:

- k_n is unitless,
- $\Delta t = 1$ s,
- s_n/m_n is in m^2 kg^{-1}, and
- $V_G - V_{\text{Gspin}}$ is in m s^{-1}.

G is therefore in m^3 s^{-2} kg^{-1}, which is well verified ($G = 6.67 \times 10^{-11}$ m^3 s^{-2} kg^{-1}).

Conclusion:

The acceleration of the flux of the medium relative to a frame of reference linked to the massive body that creates the gravitational field is given by the following formula:

$$\gamma_{\text{flux}} = \frac{GM}{r^2}. \quad (36)$$

Important note: the gravitational acceleration can also be written

$$\gamma_{\text{flux}} = K\frac{N_n s_n}{d^3}\frac{V}{r^2}, \quad \text{where} \quad K = \frac{k_n}{4\pi.\Delta t}(V_G - V_{\text{Gspin}}). \quad (37)$$

The constant K contains only quantities characteristic of the gravitons.

$K = \frac{k_n}{4\pi.\Delta t}(V_G - V_{\text{Gspin}}) = G\frac{m_n}{s_n} = 3.5 \times 10^{-8}$ m s^{-2} is an acceleration.

The formula for the acceleration γ_{flux} does not contain mass but only spatial quantities: the interatomic distance d, the cross section $N_n.s_n$ of nucleons in an atom nucleus, and the volume V of the massive body.

If we introduce N_b the total number of nucleons contained by the massive body of mass M, the acceleration of the flux of the medium can be written

$$\gamma_{\text{flux}} = K\frac{N_b.s_n}{r^2} = K\frac{s_n}{m_n}\frac{M}{r^2} = G\frac{M}{r^2} \text{ because } M \approx N_b.m_n.$$

In this approach, we neglect the mass of electrons compared with that of atomic nuclei.

2. Link between the acceleration and the speed of the flux of the medium

We have just seen that the acceleration of the flux of the medium is written [Eq. (28) and (34)]

$$\overrightarrow{\gamma_{\text{flux}}} = \frac{1}{N_{\text{tot}}}\frac{dN}{dt}.(V_{\text{Gspin}} - V_G)\overrightarrow{u_r} = -\frac{GM}{r^2}\overrightarrow{u_r}. \quad (38)$$

We deduce that $\frac{dN}{dt} = \frac{N_{\text{tot}}}{\Delta V_G}.\frac{\text{GM}}{r^2}$ with

$$\Delta V_G = V_G - V_{\text{Gspin}}. \quad (39)$$

And that the speed of the flux of the medium can be written

$$\overrightarrow{V_{\text{flux}}} = \frac{N}{N_{\text{tot}}}.(V_{\text{Gspin}} - V_G)\overrightarrow{u_r} = \frac{\sum_{i=1}^{N_{\text{tot}}}\overrightarrow{V_G}}{N_{\text{tot}}}. \quad (40)$$

In Section III C, we will show that

$$\overrightarrow{V_{\text{flux}}} = -\sqrt{\frac{2\text{GM}}{r}}\overrightarrow{u_r}. \quad (41)$$

The two last equations yield the following formula:

$$N(r) = \frac{N_{\text{tot}}}{\Delta V_G}\sqrt{\frac{2\text{GM}}{r}} \quad \text{or} \quad \frac{N(r)}{N_{\text{tot}}} = \frac{V_{\text{flux}}}{\Delta V_G}. \quad (42)$$

We will show that the formulas giving N and dN/dt are consistent and therefore also the formulas giving the acceleration and the velocity of the flux of the medium.

By deriving Eq. (42) with respect to r, we obtain

$$\frac{dN}{dr} = -\frac{N_{\text{tot}}}{2.\Delta V_G}\frac{\sqrt{2\text{GM}}}{r^{\frac{3}{2}}}. \quad (43)$$

Knowing that $dr/dt = V_{\text{flux}}^{-} = -\sqrt{2\text{GM}/r}$, we finally get

$$\frac{dN}{dt} = \frac{dN}{dr}\frac{dr}{dt} = \left(-\frac{N_{\text{tot}}}{2.\Delta V_G}\frac{\sqrt{2\text{GM}}}{r^{3/2}}\right)\left(-\sqrt{\frac{2\text{GM}}{r}}\right)$$
$$= \frac{N_{\text{tot}}}{\Delta V_G}\frac{\text{GM}}{r^2}. \quad (44)$$

We find Eq. (39), so the formulas giving N and dN/dt are consistent.

3. Case of a homogeneous ball of mass M and radius R

We consider a homogeneous ball of density ρ, mass M, and radius R.

To calculate the gravitational acceleration (acceleration of the flux of the medium), we will cut the ball into elementary crowns of dimensions $2\pi\bar{r} \times \bar{\text{dr}} \times \text{dr}$ as shown in Fig. 2.

The number of elementary cones intercepted by the surface crown $S = 2\pi\bar{r}\,.\,\bar{\text{dr}}$ is:

$N_c = \frac{S}{s_e} = \frac{2\pi\bar{r}.\bar{dr}}{\Omega_e.r_c^2}$, where $s_e = \Omega_e.r_c^2$ is the section of the elementary cone of solid angle Ω_e.

The number of slices of thickness that the interatomic distance d contained in the thickness dr of the crown is given by the following formula: $N_s = dr/d$.

We can write the gravitational acceleration (acceleration of the flux of the medium) as

$$d^2\gamma_G = F_G.k_s.k_n(V_G - V_{\text{Gspin}}).\frac{2\pi\bar{r}\,.\,\bar{\text{dr}}}{\Omega_e.r_c^2}.\frac{dr}{d}\cos(\alpha)$$
$$= G\rho\frac{2\pi\bar{r}\,.\,\bar{\text{dr}}}{r_c^2}.\cos(\alpha).dr,$$

with $\frac{F_G.k_s.k_n(V_G - V_{\text{Gspin}})}{\Omega_e d} = G\frac{N_n m_n}{d^3} = G.\rho$, $r_c^2 = r^2 + \bar{r}^2$, and $\cos(\alpha) = r/r_c$

$$d^2\gamma_G = G\rho\frac{2\pi\bar{r}\,.\,\bar{\text{dr}}}{r_c^3}.r.dr = G\rho\frac{2\pi\bar{r}\,.\,\bar{\text{dr}}}{(r^2+\bar{r}^2)^{3/2}}.r.dr,$$
$$d\gamma_G = G\rho\left[\frac{-2\pi}{\sqrt{r^2+\bar{r}^2}}\right]_0^{\bar{r}_M}.r.dr = 2\pi.G\rho\left(\frac{1}{r} - \frac{1}{\sqrt{r^2+\bar{r}_M^2}}\right)$$
$$.r.dr = 2\pi.G\rho\left(1 - \frac{r}{\sqrt{r^2+\bar{r}_M^2}}\right).dr.$$

Yet we have: $R^2 = (D-r)^2 + \bar{r}_M^2 = D^2 - 2D.r + r^2 + \bar{r}_M^2$.

That is to say, $r^2 + \bar{r}_M^2 = R^2 - D^2 + 2\text{D}.r = a.r + b$ with $a = 2.D$ and $b = \text{R}^2 - D^2$.

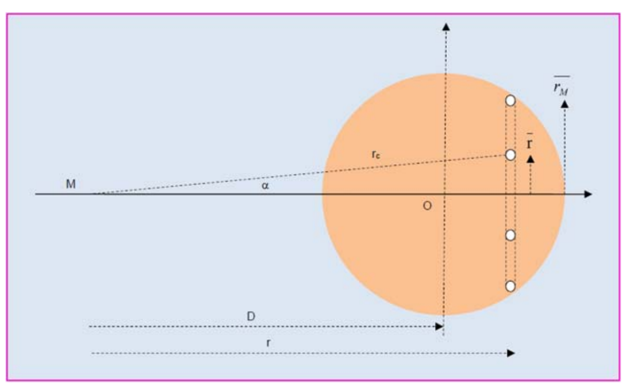

FIG. 2. (Color online) Calculation of the gravitational acceleration generated by a massive ball.

$$\frac{\gamma_G}{2\pi.G\rho}=\int_{D-R}^{D+R}\left(1-\frac{r}{\sqrt{r^2+\bar{r}_M^2}}\right)dr=\int_{D-R}^{D+R}\left(1-\frac{r}{\sqrt{a.r+b}}\right)dr,$$

$$\frac{\gamma_G}{2\pi.G\rho}=\left[r-\frac{2}{a}r\sqrt{a.r+b}\right]_{D-R}^{D+R}+\frac{2}{a}\int_{D-R}^{D+R}\sqrt{a.r+b}.dr,$$

$$\frac{\gamma_G}{2\pi.G\rho}=\left[r-\frac{2}{a}\left(r\sqrt{a.r+b}-\frac{2}{3a}(a.r+b)^{3/2}\right)\right]_{D-R}^{D+R}, \tag{45}$$

$$\frac{\gamma_G}{2\pi.G\rho}=\left[r-\frac{2}{a}\sqrt{a.r+b}\left(r-\frac{2}{3a}(a.r+b)\right)\right]_{D-R}^{D+R},$$

$$\frac{\gamma_G}{2\pi.G\rho}=\left[r-\frac{2}{3a}\sqrt{a.r+b}\left(r-\frac{2b}{a}\right)\right]_{D-R}^{D+R}.$$

By expanding and replacing a and b by their expression, we obtain

$$\frac{\gamma_G}{2\pi.G\rho}=2R-\frac{1}{3D}\sqrt{2D(D+R)+R^2-D^2}\left(D+R-\frac{R^2-D^2}{D}\right)+\frac{1}{3D}\sqrt{2D(D-R)+R^2-D^2}\left(D-R-\frac{R^2-D^2}{D}\right),$$

$$\frac{\gamma_G}{2\pi.G\rho}=2R-\frac{1}{3D}\sqrt{D^2+2DR+R^2}\left(\frac{2D^2+DR-R^2}{D}\right)+\frac{1}{3D}\sqrt{D^2-2DR+R^2}\left(\frac{2D^2-DR-R^2}{D}\right),$$

$$\frac{\gamma_G}{2\pi.G\rho}=2R-\frac{(D+R)(2D^2+DR-R^2)}{3D^2}+\frac{(D-R)(2D^2-DR-R^2)}{3D^2},$$

$$\frac{\gamma_G}{2\pi.G\rho}=2R+\frac{-6D^2R+2R^3}{3D^2}=\frac{2}{3}\frac{R^3}{D^2}.$$

From where we finally get

$$\gamma_G=\frac{4\pi.R^3}{3}\frac{G\rho}{D^2}=\frac{GM}{D^2}. \tag{46}$$

Conclusion: these calculations show that the DMR theory does not need Newton's and Poisson's gravitational equations to find the gravitational field and acceleration in the exterior case.

Important note: obtaining the formula of the gravitational acceleration from an integral on the massive body implies that we can extend the result to any body, whatever its shape and whatever its composition. It suffices to decompose the body into elementary volumes and to calculate a volume integral.

B. Acceleration of the flux of the medium in the interior case

We consider a homogeneous ball of density ρ, mass M, and radius R.

To calculate the gravitational acceleration (acceleration of the flux of the medium) at a distance r_i from the center of gravity of the ball, we will cut the ball into two parts delimited by the plane δ perpendicular to the line (OM) and passing through the point $M\ (r_i)$ as shown in Fig. 3.

We will first calculate the gravitational acceleration (acceleration of the flux of the medium) corresponding to the first part of the ball (see Fig. 3).

The calculations are identical to the exterior case up to the following formula obtained by integrating r from 0 to R-r_i:

$$\frac{\gamma_{G1}}{2\pi.G\rho}=\left[r-\frac{2}{3a}\sqrt{a.r+b}\left(r-\frac{2b}{a}\right)\right]_0^{R-r_i}, \tag{47}$$

with $R^2=(r_i+r)^2+\bar{r}_M^2=r_i^2+2r_i.r+r^2+\bar{r}_M^2$.

That is to say, $r^2 + \bar{r}_M^2 = R^2 - r_1^2 - 2r_i.r = a.r + b$ with $a = -2.r_i$ and $b = R^2 - r_i{}^2$.

By expanding and replacing a and b by their expression, we obtain

$$\begin{aligned}
\frac{\gamma_{G1}}{2\pi.G\rho} &= R - r_i + \frac{1}{3.r_i}\sqrt{-2r_i(R-r_i) + R^2 - r_i^2}\left(R - r_i + \frac{R^2 - r_i^2}{r_i}\right) - \frac{1}{3.r_i}\sqrt{R^2 - r_i^2}\left(\frac{R^2 - r_i^2}{r_i}\right),\\
\frac{\gamma_{G1}}{2\pi.G\rho} &= R - r_i + \frac{(R-r_i)\left(R.r_i - 2r_i^2 + R^2\right) - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2},\\
\frac{\gamma_{G1}}{2\pi.G\rho} &= R - r_i + \frac{R^3 - 3.r_i^2.R + 2.r_i^3 - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2},\\
\gamma_{G1} &= 2\pi.G\rho\frac{R^3 - r_i^3 - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2}.
\end{aligned} \tag{48}$$

We will now calculate the gravitational acceleration (acceleration of the flux of the medium) corresponding to the second part of the ball (see Fig. 3).

The calculations are identical to the exterior case up to the following formula obtained by integrating r from 0 to $R + r_i$:

$$\frac{\gamma_{G2}}{2\pi.G\rho} = \left[r - \frac{2}{3a}\sqrt{a.r+b}\left(r - \frac{2b}{a}\right)\right]_0^{R+r_i},$$

with $R^2 = (r - r_i)^2 + \bar{r}_M^2 = r_i^2 - 2r_i.r + r^2 + \bar{r}_M^2$.

That is to say, $r^2 + \bar{r}_M^2 = R^2 - r_i^2 + 2r_i.r = a.r + b$ with $a = 2.r_i$ and $b = R^2 - r_i{}^2$.

By expanding and replacing a and b by their expression, we obtain

$$\begin{aligned}
\frac{\gamma_{G2}}{2\pi.G\rho} &= R + r_i - \frac{1}{3.r_i}\sqrt{2r_i(R+r_i) + R^2 - r_i^2}\left(R + r_i - \frac{R^2 - r_i^2}{r_i}\right) - \frac{1}{3.r_i}\sqrt{R^2 - r_i^2}\left(\frac{R^2 - r_i^2}{r_i}\right),\\
\frac{\gamma_{G2}}{2\pi.G\rho} &= R + r_i - \frac{(R+r_i)\left(R.r_i + 2r_i^2 - R^2\right) + \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2},\\
\frac{\gamma_{G2}}{2\pi.G\rho} &= R + r_i + \frac{R^3 - 3.r_i^2.R - 2.r_i^3 - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2},\\
\gamma_{G2} &= 2\pi.G\rho\frac{R^3 + r_i^3 - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2}.
\end{aligned} \tag{49}$$

In the end, the total acceleration is obtained by subtracting the two accelerations since the two parts of the ball generate opposite gravitational fields and accelerations

$$\begin{aligned}
\gamma_{G\,\mathrm{total}} &= \gamma_{G2} - \gamma_{G1} = 2\pi.G\rho\frac{R^3 + r_i^3 - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2} - 2\pi.G\rho\frac{R^3 - r_i^3 - \left(R^2 - r_i^2\right)^{3/2}}{3.r_i^2} = 2\pi.G\rho\frac{2.r_i^3}{3.r_i^2},\\
\gamma_{G\,\mathrm{total}} &= \gamma_{G2} - \gamma_{G1} = \frac{4\pi}{3}G\rho.r_i = GM\frac{r_i}{R^3}.
\end{aligned} \tag{50}$$

Conclusion: these calculations show that the DMR theory does not need Newton's and Poisson's gravitational equations to find the gravitational field and acceleration in the interior case.

Important note: obtaining the formula for gravitational acceleration from an integral on the massive body implies that we can extend the result to any body, whatever its shape and whatever its composition. It suffices to decompose the body into elementary volumes and to calculate a volume integral.

C. Speed of the flux of the medium in the exterior case

Within the framework of the theory of the DMR, the gravitational field is the acceleration of the flux of the medium:

$$\overrightarrow{\gamma_{\mathrm{flux}}}(r) = \overrightarrow{G}(r) = -\frac{\mathrm{GM}}{r^2}\overrightarrow{u_r}. \tag{51}$$

The link between the acceleration and the speed of the flux of the medium is given by the following formula:

$$\gamma_{\mathrm{flux}} = \frac{dV_{\mathrm{flux}}}{dt} = \frac{dV_{\mathrm{flux}}}{dr}\frac{dr}{dt} = \frac{dV_{\mathrm{flux}}}{dt}V_{\mathrm{flux}} = \frac{d}{dr}\left(\frac{V_{\mathrm{flux}}^2}{2}\right).$$

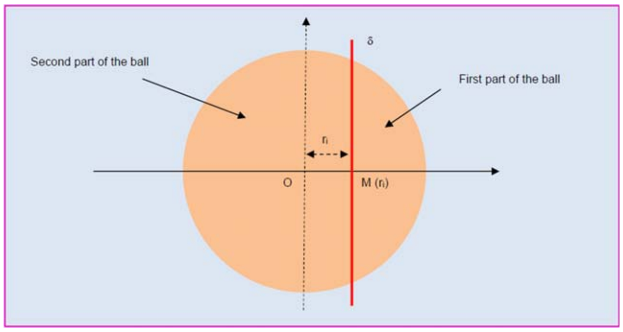

FIG. 3. (Color online) Calculation of the gravitational acceleration inside a massive ball.

The speed of the flux of the medium is therefore obtained by the following formula:

$$V_{\text{flux}}^2 = \int 2\gamma_{\text{flux}} dr = \int \left(-2\frac{\text{GM}}{r^2}\right) dr = \frac{2\text{GM}}{r} + C.$$

At an infinite distance from the spherical body, the speed of the flux of the medium is zero whence $C = 0$ and finally

$$V_{\text{flux}}^2(r) = \frac{2\text{GM}}{r}. \tag{52}$$

Note: the Poisson equation in the exterior case is written $\Delta\phi = 0$, where ϕ denotes the gravitational potential and has for solution: $\phi(r) = -GM/r$.

We therefore have the important relation

$$V_{\text{flux}}^2(r) = -2\phi(r). \tag{53}$$

D. Speed of the flux of the medium in the interior case

Within the framework of the theory of the DMR, the gravitational field is the acceleration of the flux of the medium

$$\overrightarrow{\gamma_{\text{flux}}}(r) = \vec{G}(r) = -\left(\frac{\text{GM}}{R^3} r\right)\vec{u_r}. \tag{54}$$

The link between the acceleration and the speed of the flux of the medium is given by the following formula:

$$\gamma_{\text{flux}} = \frac{dV_{\text{flux}}}{dt} = \frac{dV_{\text{flux}}}{dr}\frac{dr}{dt} = \frac{dV_{\text{flux}}}{dt} V_{\text{flux}} = \frac{d}{dr}\left(\frac{V_{\text{flux}}^2}{2}\right).$$

The speed of the flux of the medium is therefore obtained by the following formula:

$$V_{\text{flux}}^2 = \int 2\gamma_{\text{flux}} dr = \int \left(-2\frac{\text{GM}}{R^3} r\right) dr = -\frac{2\text{GM}}{R^3}\frac{r^2}{2} + C.$$

At the surface of the spherical body ($r = R$), the speed of the flux of the medium is obtained by the following formula: $V_{\text{flux}}^2 = 2\text{GM}/R$.

Now we have: $V_{\text{flux}}^2(\text{R}) = -(2\text{GM}/R^3)(R^2/2) + C = -(\text{GM}/R) + C$ whence $C = 3(\text{GM}/R)$ and finally

$$V_{\text{flux}}^2(r) = \frac{\text{GM}}{R}\left(3 - \frac{r^2}{R^2}\right). \tag{55}$$

Note: the Poisson equation in the interior case is written $\Delta\phi = 4\pi G\rho$, where ϕ denotes the gravitational potential and has for solution

$$\phi(r) = -\frac{\text{GM}}{2R}\left(3 - \frac{r^2}{R^2}\right).$$

We therefore have the important relation

$$V_{\text{flux}}^2(r) = -2\phi(r). \tag{56}$$

The relation $V_{\text{flux}}^2 = -2\phi$ linking the gravitational potential to the speed of the flux of the medium is thus valid in the exterior case and in the interior case.

In the theory of the DMR, the gravitational potential is in fact, to a factor (-2), the square of the speed of the flux of the medium.

Special case of the center of gravity of the massive body:

On a small sphere of radius ε around the center of gravity of the massive body, the flux of the medium is centripetal and its speed vector at each point M_ε of the sphere is

$$\overrightarrow{V_{\text{flux}}}(M_\varepsilon) = -\sqrt{\frac{\text{GM}}{R}\left(3 - \frac{\varepsilon^2}{R^2}\right)}\vec{u_r}.$$

The gravitational potential, meanwhile, is equal to

$$\phi(M_\varepsilon) = -\frac{\text{GM}}{2R}\left(3 - \frac{\varepsilon^2}{R^2}\right).$$

For the particular case of the center of gravity C of the massive body, it is in fact necessary to make the vector sum of all the fluxes located on all the points M_ε of the sphere

$$\overrightarrow{V_{\text{flux}}}(C) = \sum_{i=1}^{N} \overrightarrow{V_{\text{flux}}}(M_i) = \vec{0}. \tag{57}$$

This vector sum is zero since the velocity vectors of the flux of the medium are all radial and centripetal, come from all directions, and have the same modulus.

The gravitational potential, meanwhile, is not zero and is equal to $\phi(0) = -3\text{GM}/2R$, which seems counterintuitive taking into account the symmetry of revolution of the situation, and we do not see what potential energy of gravitation would have a small material body in the center of the massive body and towards where it could "fall."

Note : There is never an accumulation of gravitons at the center of the massive body because the velocity of the flux of the medium is a vector average of the velocity vectors of the gravitons. The gravitons themselves always pass through the massive body, exit the massive body, and continue their course in space.

IV. GENERAL RELATIVITY

A. Schwarzschild metric of the interior case

We consider that the Schwarzschild metric in the exterior case is known,[4,7] and we want to establish the Schwarzschild metric in the interior case.

The Schwarzschild metric (metric tensor) is equivalent to the fundamental quadratic form ds^2. which can be written in the interior case[4]

$$ds^2 = A(r)c^2dt^2 - B(r)dr^2 - r^2d\theta^2 - r^2\sin^2\theta.d\phi^2. \tag{58}$$

We use the Einstein equation

$$R_{ij} = -\kappa\left(T_{ij} - \frac{T}{2}g_{ij}\right), \tag{59}$$

with $T_{ij} = (\rho + p/c^2).u_iu_j - pg_{ij}$ and $T = \rho c^2 - 3p$ and $[u_i] = c\sqrt{A}(1,0,0,0)$.

Einstein's equations are therefore written[4]

$$\begin{cases} R_{00} = -\dfrac{A''}{2B} + \dfrac{A'}{4B}\left(\dfrac{A'}{A} + \dfrac{B'}{B}\right) - \dfrac{A'}{rB} = -\dfrac{\kappa}{2}(\rho c^2 + 3p)A, \\ R_{11} = \dfrac{A'}{2A} - \dfrac{A'}{4A}\left(\dfrac{A'}{A} + \dfrac{B'}{B}\right) - \dfrac{B'}{rB} = -\dfrac{\kappa}{2}(\rho c^2 - p)B, \\ R_{22} = \dfrac{1}{B} - 1 + \dfrac{r}{2B}\left(\dfrac{A'}{A} - \dfrac{B'}{B}\right) = -\dfrac{\kappa}{2}(\rho c^2 - p).r^2, \\ R_{33} = \dfrac{1}{B} - 1 + \dfrac{r}{2B}\left(\dfrac{A'}{A} - \dfrac{B'}{B}\right)\sin^2\theta = -\dfrac{\kappa}{2}(\rho c^2 - p).r^2\sin^2\theta. \end{cases}$$

B. Case of a massive body composed of an incompressible and nonrelativistic fluid

The case of stars for which the pressure is not negligible is often dealt with in books of General Relativity[4,7] but not the case where the pressure is negligible compared with ρc^2.

In the case of a massive body composed of an incompressible ($\rho =$ constant) and nonrelativistic ($p \ll \rho c^2$) fluid, Einstein's equations are written

$$\begin{cases} R_{00} = -\dfrac{A''}{2B} + \dfrac{A'}{4B}\left(\dfrac{A'}{A} + \dfrac{B'}{B}\right) - \dfrac{A'}{rB} = -\dfrac{\kappa}{2}\rho c^2 A, \\ R_{11} = \dfrac{A''}{2A} - \dfrac{A'}{4A}\left(\dfrac{A'}{A} + \dfrac{B'}{B}\right) - \dfrac{B'}{rB} = -\dfrac{\kappa}{2}\rho c^2 B, \\ R_{22} = \dfrac{1}{B} - 1 + \dfrac{r}{2B}\left(\dfrac{A'}{A} - \dfrac{B'}{B}\right) = -\dfrac{\kappa}{2}\rho c^2.r^2, \\ R_{33} = \dfrac{1}{B} - 1 + \dfrac{r}{2B}\left(\dfrac{A'}{A} - \dfrac{B'}{B}\right)\sin^2\theta = -\dfrac{\kappa}{2}\rho c^2.r^2\sin^2\theta. \end{cases}$$

We can write

$$\begin{aligned} \frac{R_{00}}{A} + \frac{R_{11}}{B} &= -\frac{A''}{2AB} + \frac{A'}{4AB}\left(\frac{A'}{A} + \frac{B'}{B}\right) - \frac{A'}{\mathrm{rAB}} + \frac{A''}{2AB} \\ &\quad - \frac{A'}{4AB}\left(\frac{A'}{A} + \frac{B'}{B}\right) - \frac{B'}{rB^2} \\ &= -\kappa\rho c^2. \end{aligned}$$

By simplifying we obtain

$$\begin{aligned} &\frac{R_{00}}{A} + \frac{R_{11}}{B} = -\frac{A'}{\mathrm{rAB}} - \frac{B'}{rB^2} = -\kappa\rho c^2 \quad \text{or even} \\ &\frac{A'}{A} + \frac{B'}{B} = \kappa\rho c^2 rB. \end{aligned} \tag{60}$$

By replacing A'/A in R_{22}, we get

$$R_{22} = \frac{1}{B} - 1 + \frac{r}{2B}\left(\kappa\rho c^2 rB - \frac{2B'}{B}\right) = -\frac{\kappa}{2}\rho c^2.r^2,$$

what can be written

$$\frac{rB'}{B^2} - \frac{1}{B} + 1 = \kappa\rho c^2.r^2. \tag{61}$$

The left side is recognized as the derivative of $r(1-(1/B))$.

By integrating we thus obtain: $r(1-(1/B)) = \frac{1}{3}\kappa\rho c^2.r^3 + C$,

which gives: $B = \left(1 - \frac{1}{3}\kappa\rho c^2.r^2 - \frac{C}{r}\right)^{-1}$.

Moreover, $\kappa = 8\pi G/c^4$ and $M = (4\pi/3)\rho.R^3$ whence $\kappa\rho = 6\mathrm{GM}/c^4R^3 = 3\alpha/c^2R^2$, where $\alpha = 2\mathrm{GM}/c^2R$.

So we have: $B = \left(1 - \alpha\frac{r^2}{R^2} - \frac{C}{r}\right)^{-1}$.

Now, we know that in the case of the exterior Schwarzschild metric, the coefficient B is written

$$B(R) = \left(1 - \frac{2\mathrm{GM}}{c^2R}\right)^{-1} = (1-\alpha)^{-1}.$$

This leads to $C = 0$ and therefore finally

$$B(r) = \left(1 - \alpha\frac{r^2}{R^2}\right)^{-1}. \tag{62}$$

To determine the function A we use the relation (60) then the relation (61) written in the form

$$\begin{aligned} &\frac{B'}{B} = \kappa\rho c^2 rB - \frac{B}{r} + \frac{1}{r}: \\ &\frac{A'}{A} = \kappa\rho c^2 rB - \frac{B'}{B} = \kappa\rho c^2 rB - \left(\kappa\rho c^2 rB - \frac{B}{r} + \frac{1}{r}\right) \\ &\quad = \frac{B}{r} - \frac{1}{r} = \frac{1}{r(1-\alpha.r^2/R^2)} - \frac{1}{r} = \frac{1}{r}.\frac{1-\left(1-\alpha.r^2/R^2\right)}{1-\alpha.r^2/R^2}. \end{aligned}$$

Finally, we have

$$\frac{A'}{A} = \frac{\alpha.r/R^2}{1-\alpha.r^2/R^2}. \tag{63}$$

By integrating, we obtain

$$\ln(A) = -\frac{1}{2}\ln\left(1 - \alpha.r^2/R^2\right) + C,$$

whence $A = e^C(1 - \alpha.r^2/R^2)^{-1/2}$.

Now we know that in the case of the **exterior** Schwarzschild metric, we have

$$A(R) = 1 - (2\mathrm{GM}/c^2R) = 1 - \alpha, \text{ which gives}$$
$$e^C = \left(1 - (2GM/c^2R)\right)^{3/2}.$$

Finally,

$$A(r) = (1-\alpha)^{3/2}\left(1 - \alpha\frac{r^2}{R^2}\right)^{-1/2} = (1-\alpha)^{3/2}\sqrt{B(r)} \quad \text{with} \quad \alpha = \frac{2\mathrm{GM}}{c^2R}. \tag{64}$$

V. LINK BETWEEN THE DMR AND GENERAL RELATIVITY

A. Link between the DMR and general relativity in the exterior case

In general relativity, gravity is a distortion of space-time described by a Riemannian metric.

The Schwarzschild metric (metric tensor) is equivalent to the fundamental quadratic form ds^2, which can be written in the exterior case[8]

$$ds^2 = \sum_{i,j=0}^{3} g_{ij}dx^i dx^j = g_{00}c^2dt^2 + g_{11}dr^2 + g_{22}d\theta^2 + g_{33}d\phi^2, \tag{65}$$

with $g_{00} = 1 - \frac{2\mathrm{GM}}{c^2r}$, $g_{11} = -\left(1 - \frac{2\mathrm{GM}}{c^2r}\right)^{-1}$, $g_{22} = -r^2$, and $g_{33} = -r^2\sin^2\theta$.

We have the following link[8] between the proper time t_0 and the coordinate $x^0 = ct$:

$dt_0 = \sqrt{g_{00}}dt$ that we can write : $g_{00} = \left(\frac{dt_0}{dt}\right)^2 = 1 - \frac{2GM}{c^2r}$.

In the theory of the DMR,[1] we saw in the first part the following point:

In the presence of a massive body of mass M, material clocks undergo a physical dilatation of their period according to the following formula:[1]

$$T = T_0 \cdot K(r) \quad \text{with} \quad K(r) = \left(1 - \frac{V_{\text{flux}}^2}{c_0^2}\right)^{-1/2} = \left(1 - \frac{2GM}{c_0^2 \cdot r}\right)^{-1/2} \tag{66}$$

It is therefore possible to make a link between g_{00} and the speed of the flux of the medium

$$g_{00} = \left(\frac{dt_0}{dt}\right)^2 \equiv \left(\frac{T_0}{T}\right)^2 = 1 - \frac{V_{\text{flux}}^2}{c_0^2}. \tag{67}$$

Similarly, there is a link[8] between the proper length l_0 and the coordinate $x^1 = r$

$dl_0 = (-g_{11})^{1/2}dr$ that we can write

$$-g_{11} = \left(\frac{dl_0}{dr}\right)^2 = \left(1 - \frac{2\mathrm{GM}}{c^2r}\right)^{-1}.$$

In the theory of the DMR,[1] we saw in the first part the following point:

In the presence of a massive body of mass M, material rulers undergo a physical contraction of their length according to the following formula:[1]

$$L = \frac{L_0}{K(r)} \text{ with } \mathrm{K}(r) = \left(1 - \frac{V_{\text{flux}}^2}{c_0^2}\right)^{-1/2} = \left(1 - \frac{2GM}{c_0^2 \cdot r}\right)^{-1/2} \tag{68}$$

It is therefore possible to make a link between g_{11} and the speed of the flux of the medium

$$-g_{11} = \left(\frac{dl_0}{dr}\right)^2 \equiv \left(\frac{L_0}{L}\right)^2 = \left(1 - \frac{V_{\text{flux}}^2}{c_0^2}\right)^{-1}. \tag{69}$$

The theory of the DMR finds exactly the same coefficients as those of the metric of General Relativity in the external case.

Note: the objective of the DMR theory is not to find Einstein's equations since in the DMR theory the temporal axis, the time dimension does not exist and gravitation is not a deformation of the space-time.

The interpretations of the two theories are completely different.[1] In the DMR theory, physical reality is the universal present moment. (The past no longer exists and the future is open.)

On the other hand, the DMR theory finds expressions identical to general relativity concerning the dilatation of durations and the contraction of lengths in the presence of a gravitational field as well as the equations of motion for a photon and a material particle.[1]

B. Link between the DMR and general relativity in the interior case

In the interior case of general relativity, we expressed the fundamental quadratic form ds^2 in the fourth part as follows:

$$ds^2 = A(r)c^2dt^2 - B(r)dr^2 - r^2d\theta^2 - r^2\sin^2\theta.d\phi^2.$$

We have found

$$g_{00} = \left(\frac{dt_0}{dt}\right)^2 = A(r) = (1-\alpha)^{3/2}\left(1 - \alpha\frac{r^2}{R^2}\right)^{-1/2} \quad \text{with} \quad \alpha = \frac{2\mathrm{GM}}{c^2R}$$

$$-g_{11} = \left(\frac{dl_0}{dr}\right)^2 = B(r) = \left(1 - \alpha\frac{r^2}{R^2}\right)^{-1}.$$

In the DMR theory, we have found

$$\left(\frac{T_0}{T}\right)^2 = 1 - \frac{V_{\text{flux}}^2}{c^2} = 1 - \frac{\mathrm{GM}}{c^2R}\left(3 - \frac{r^2}{R^2}\right), \tag{70}$$

$$\left(\frac{L_0}{L}\right)^2 = \left(1 - \frac{V_{\text{flux}}^2}{c^2}\right)^{-1} = \left[1 - \frac{\text{GM}}{c^2R}\left(3 - \frac{r^2}{R^2}\right)\right]^{-1}. \tag{71}$$

In the frame of general relativity, in the case of weak fields ($\alpha \ll 1$), which is the case of the solar system, we have

$$g_{00} = \left(\frac{dt_0}{dt}\right)^2 = A(r) \approx \left(1 - \frac{3}{2}\alpha\right)\left(1 + \frac{\alpha}{2}\frac{r^2}{R^2}\right)$$
$$\approx 1 - \frac{3}{2}\alpha + \frac{\alpha}{2}\frac{r^2}{R^2} = 1 - \frac{\text{GM}}{c^2R}\left(3 - \frac{r^2}{R^2}\right), \tag{72}$$

$$-g_{11} = \left(\frac{dl_0}{dr}\right)^2 = B(r) \approx 1 + \frac{2\text{GM}}{c^2R}\frac{r^2}{R^2}. \tag{73}$$

The two theories give the same coefficient g_{00} in the case of weak fields, but not the same coefficient g_{11}.

On the other hand for $r = R$, the two theories give the same exact coefficients

$$g_{00} = \left(\frac{dt_0}{dt}\right)^2 = A(R) = 1 - \frac{2\text{GM}}{c^2R} = 1 - \alpha, \tag{74}$$

$$-g_{11} = \left(\frac{dl_0}{dr}\right)^2 = B(R) = \left(1 - \frac{2\text{GM}}{c^2R}\right)^{-1}$$
$$= (1 - \alpha)^{-1}. \tag{75}$$

VI. REFLECTIONS ON GENERAL RELATIVITY AND ON THE DMR

A. General relativity

General relativity is an elegant theory that has the power of the mathematics on which it is based. This theory has been shown to be predictive and has been largely confirmed by experimentation.[4]

However, this theory has weaknesses.

I do not want to talk here about dark matter and dark energy that scientists postulate so that the theory "sticks" to observations, but the following points:

- The theory needs Newton's gravitational theory (or equivalently the Poisson equation) to adjust its parameters. Its parameters or coefficients are at least two in number and their expression is obtained in the context of weak fields thanks to the Newtonian gravitational potential $\phi = -\text{GM}/r$ concerning the universal gravitational constant G and thanks to the Poisson equation of the interior case concerning the coefficient $\kappa = 8\pi.G/c^4$.
- The theory does not explain how, by what "mechanism," a massive body curves space-time. Of course, the principle of equivalence, which, let us remember, is only a principle and is therefore not demonstrated, implies that, if the temporal dimension exists, then it is distorted, just like the three spatial dimensions. However, if the reason why space-time is deformed seems to be verified (the principle of equivalence has been verified experimentally with great precision), the how is not provided by the theory and remains a mystery.
- Relativity imposes a relative notion of simultaneity. A first observer will declare that two events A and B are simultaneous, a second observer will declare that event A has taken place before event B, and a third observer will declare that event B has taken place before event A. This view is true for the "optical images" of events (*) but is false for the events themselves.
- The equations of General relativity leads to singularities in certain cases (Big Bang, black holes).
- The last point is certainly the most important: The theory of relativity, and more particularly the theory of general relativity, require the real, physical existence of the time dimension. The time axis really exists physically. This means that all past, present, and future events, up to infinite time, exist eternally. This vision involves the possibility, at least in principle, of time travel, and we know that travel in the past is the source of innumerable paradoxes, the present in which we live is only an illusion as well as our free will, since future events are already "set in stone" in the Block Universe.

(*) we call "optical image" of an event, the light emitted or reflected by the object concerned by the event at the time of the event. This optical image propagates at the speed of light and can be received at different times by different observers.

B. Dynamic Medium of Reference

The theory of the DMR gives the same main results of general relativity.

The mathematics on which it is based are simpler than that of general relativity. Most often it is a matter of performing integrals taking into account the distribution of matter in order to find the acceleration and the speed of the flux of the medium.

The theory allows to give a more fundamental expression to the universal constant of gravitation $G = \frac{k_n}{4\pi}\frac{s_n}{m_n}(V_G - V_{\text{Gspin}})$, in which intervenes some characteristics of the gravitons (k_n, V_G, V_{Gspin}) as well as the characteristics of the nucleons (s_n, m_n) with which they interact.

The theory of the DMR only requires considering three dimensions, the three spatial dimensions, and the time dimension or time axis does not exist. Time emerges from the movement of all bodies, from gravitons to the most gigantic cosmic bodies, and from the evolution of all physical phenomena.

The dynamic medium makes it possible to obtain a Preferred Frame of Reference (without gravitational field) and a **REFERENCE** (with gravitational field), which makes it possible to define an absolute simultaneity and a privileged time everywhere in the Universe. Physical reality is the universal present moment.

A theory with a medium and a privileged time could make quantum mechanics and a theory of gravitation

TABLE I. Distinction between the fields (electric, magnetic, gravitation) propagating at the speed of gravitons and the electromagnetic and gravitational waves propagating at the speed of light

Speed of propagation	Gravitation	Electromagnetism
Field	Field of gravitation	Fields $\vec{E}$ and $\vec{B}$
	Speed of the gravitons $V_G \gg c$	Speed of the gravitons $V_G \gg c$
Waves	Gravitational waves[10,11]	Electromagnetic waves
	Speed of light c	Speed of light c

compatible and succeed in their unification. Indeed, quantum mechanics was originally built in a flat space-time and it uses a privileged time.

Finally, the theory of the DMR makes it possible to explain in a fairly simple and natural way the enormous difference between vacuum energy and dark energy.[9]

C. Equivalence principle—gravitational mass—inertial mass

In the context of general relativity, the principle of equivalence is essential since it is the link between special relativity and general relativity. However, this essential principle has not been demonstrated.

In the context of general relativity, a particle attracted by a massive body does not need to be assigned a gravitational mass, because it simply follows a geodesic of space-time bent by the massive body.

Regarding the inertial mass of a particle, it is due to the Higgs field, Higgs boson, and Higgs mechanism.

It seems difficult to reconcile these two very different visions, that of general relativity and that of quantum mechanics, concerning the mass of a particle.

Within the framework of the DMR theory, the principle of equivalence is demonstrated quite naturally[1] since:

The effects due to the movement of a particle relative to the medium are equivalent to the effects due to the movement of the medium (due to a massive body) relative to a particle.

Likewise, the equivalence between inertial mass and gravitational mass is obtained quite naturally since:

The acceleration of a particle with respect to the medium (cause of the inertial force and the centrifugal force) is equivalent to the acceleration of the medium with respect to the particle (cause of the gravitational force).

VII. ARGUMENTS IN FAVOR OF A SPEED OF GRAVITONS MUCH GREATER THAN THE SPEED OF LIGHT

The theory of the DMR distinguishes between:

- The gravitational field which propagates at the speed of the gravitons V_G. The gravitational field, mainly created by massive bodies (like planets and stars), causes the planets to revolve around the Sun and an object to fall to the ground. It can exist without the presence of gravitational waves.
- Gravitational waves that propagate at the speed of light.[10,11]

General relativity implies a single speed (that of light) for the gravitational field and gravitational waves, but this is not a requirement for all theories of gravity.

Likewise, the theory of the DMR makes a distinction between:

- The electric field and the magnetic field, which propagate at the speed of the gravitons. This is justified by the fact that in the DMR theory all fields propagate at the speed of gravitons and the fundamental forces are due to fluxes of the medium (vector average of fluxes of gravitons).
- Electromagnetic waves that propagate at the speed of light.

Table I summarizes the above remarks,

The arguments in favor of a speed of gravitons much greater than the speed of light are as follows:

- radial flux of the medium generated by a massive body,
- speed of the flux of the medium inside the horizon of a black hole,
- quantum entanglement of two photons moving away in opposite directions,
- explanation of the enormous difference between vacuum energy and dark energy,
- isotropy and isothermy of the Cosmic Microwave Background Radiation (CMBR),
- period of inflation after the Big Bang, and
- circulation of gravitons in the Multiverse.

A. Radial flux of the medium generated by a massive body

A massive, nonrotating, homogeneous body generates a radial and centripetal flux of the medium. This element implies that the flux of the medium must be regenerated at a speed much greater than that of light as the massive body moves.

Eddington[12] explains the problem for gravitation acting at the speed of light with these words:

> "If the Sun attracts Jupiter towards its present position S, and Jupiter attracts the Sun towards its present position J, the two forces are in the same line and balance. But if the Sun attracts Jupiter towards its previous position S′, and Jupiter attracts the Sun towards its previous position J′, when the force of attraction started out to cross the gulf, then the two forces give a couple. This couple will tend to increase the angular momentum of the system, and, acting cumulatively, will soon cause an appreciable of period, disagreeing with observations if the speed is at all comparable with that of light."

We can add the following consideration:

Consider a vertically falling rain encountered by a rapidly moving train. The faster the train moves, the more slanted from the forward direction the rainfall appears. The faster the Earth's motion, the more slanted in the forward direction the sunlight (and by extension, its gravity, if it traveled at the speed of light) would appear to be. The Sun would then always have a forward-pulling component to its force which would accelerate the Earth. The absence of an observed orbital acceleration of the Earth about the Sun places a lower limit to the speed of propagation of gravitational agents between the Sun and Earth. This lower limit is about eight times the speed of light.

B. Speed of the flux of the medium inside the horizon of a black hole

In general relativity, a stationary black hole, without rotation and without electric charge, is described by the metric of Schwarzschild[4]

$$ds^2 = \left(1 - \frac{2\mathrm{GM}}{c_0^2 r}\right) c_0^2 dt^2 - \left(1 - \frac{2\mathrm{GM}}{c_0^2 r}\right)^{-1} dr^2 - r^2 d\vartheta^2 - r^2 \sin^2\vartheta . d\varphi^2. \quad (76)$$

A black hole is bounded by the Schwarzschild radius $r_S = 2\mathrm{GM}/c_0^2$ called the horizon of the black hole. Inside the horizon, nothing can escape from the black hole, not even light (Fig. 4).

In the theory of the DMR, a black hole generates a centripetal flux of the medium (radial and directed toward the center of the black hole) whose speed has for expression[1,3]

$$V_{\mathrm{flux}} = \sqrt{\frac{2\mathrm{GM}}{r}} = c_0 \sqrt{\frac{r_S}{r}}. \quad (77)$$

Beyond the horizon of a black hole ($r > r_s$) given by the Schwarzschild radius $r_S = 2\mathrm{GM}/c^2$, the speed of the flux of the medium is lower than the speed of light.

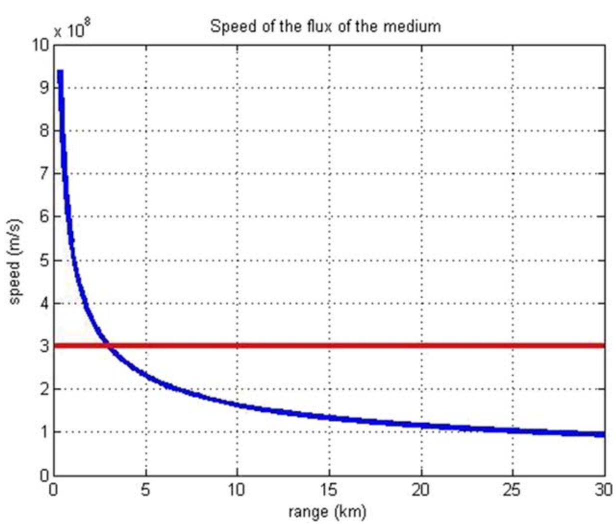

FIG. 4. (Color online) Speed of the flux of the medium.

However, inside the horizon of a black hole ($r < r_s$), the speed of the flux of the medium is greater than the speed of light.

Moreover, for a distance to the center of the black hole much less than the Schwarzschild radius ($r \ll r_s$), the speed of the flux of the medium is much greater than the speed of light ($V_{\mathrm{flux}} \gg c$).

For a distance r corresponding to the Planck length $L_P = \sqrt{Gh/2\pi.c^3} = 1.616 \times 10^{-35}$ m, the speed of the flux of the medium is: $V_{\mathrm{flux}} = \sqrt{2\mathrm{GM}/L_P} = 2.87 \times 10^{12}\sqrt{M}$.

For a black hole of a solar mass ($M_s = 2 \times 10^{30}$ kg), the speed of the flux of the medium is

$$V_{\mathrm{flux}} = 4 \times 10^{27}\ \mathrm{m/s}.$$

Inside the horizon of a black hole is the only place in the current Universe, where the speed of the flux of the medium is greater than the speed of light (at macroscopic scale).

This result is of primary importance.

The speed vector of the flux of the medium at a point M in space is given by the average of the speed vectors of all the gravitons located in the elementary volume centered in M

$$\overrightarrow{V_{\mathrm{flux}/R}}(M) = \frac{\sum_{i=1}^{N_G} \overrightarrow{\mathrm{V}_{G/R}}}{N_G}. \quad (78)$$

Here, R denotes any inertial reference frame and N_G is the number of gravitons contained in the elementary volume centered in M.

If all the gravitons moved at the speed of light, the speed of the flux would be less than or equal to the speed of light. (Equality would be reached in the case where all the gravitons in a given elementary volume would move in the same direction.)

A speed of the flux of the medium much higher than the speed of light, which is the case at a distance very close to the center of a black hole ($r \ll r_s$), implies that the speed of the gravitons themselves is much higher than the speed of light.

C. Quantum entanglement of two photons moving away in opposite directions

In *The Ghost in the Atom,*[13] there is the following discussion about the EPR experiment and locality (p. 39):

"If locality is abandoned, it is possible to recreate a description of the microworld closely similar to that of the everyday world, with objects having a concrete independent existence in well-defined states and possessing complete sets of physical attributes. No need for fuzziness now.

The trade-off is, of course, that nonlocal effects bring their own crop of difficulties; specifically, the ability for signals to travel backwards into the past. This would open the way to all sorts of causal paradoxes."

It is essential to be aware that all these difficulties are only in Einstein's vision, i.e., the special relativity (and general relativity).

If one chooses the version of Lorentz and Poincaré, all these difficulties disappear.

In *The Ghost in the Atom*,[13] John Bell says about the EPR paradox (p. 48): "I would say that the cheapest resolution is something like going back to relativity as it was before Einstein, **when people like Lorentz and Poincaré thought that there was an aether - a preferred frame of reference** - but that **our measuring instruments were distorted by motion in such a way that we could not detect motion through the aether**. Now, in that way you can imagine that there is a preferred frame of reference, and in this preferred frame of reference things do go faster than light."

In the same book,[13] David Bohm says about locality: "**I would be quite ready to relinquish locality**; I think it is an arbitrary assumption." and Basil Hiley says about non locality: "If you have an **absolute spacetime**, or an **absolute time**, **in the background** then you don't get into causal loops. So the causal paradoxes won't arise."

The entanglement of two particles (let us say two photons) could be realized by the proposed gravitons which move much faster than light.

To determine the speed of gravitons, one reasoning is to consider that the connection between two particles remains even if the two particles are situated at two opposite extremities of our Universe and that our more accurate instruments cannot detect a duration between the measurement of the first particle and the measurement of the second particle, i.e., the duration is smaller than the Planck time $t_{\text{Planck}} = 5.4 \times 10^{-44}$ s.

So we obtain the following speed for the gravitons and the speed of gravitation:

$$V_G \approx \frac{R_{\text{Universe}}}{t_{\text{Planck}}} \text{ which gives : } V_G \approx \frac{13.7 \times 10^9 AL}{5.4 \times 10^{-44}} = 2.4 \times 10^{69}\ \text{m/s}. \tag{79}$$

It is only in Einstein's version (the theory of relativity) that nothing can move faster than light.

D. Explanation of the enormous difference between vacuum energy and dark energy

Within the framework of the DMR theory, the ratio of vacuum energy to dark energy is given by the following formula:[9]

$$\frac{E_{\text{vacuum}}}{E_{\text{dark}}} \approx \left(\frac{V_G}{C_G}\right)^2. \tag{80}$$

This can provide us an estimation of the average speed of the gravitons using the approximation $C_G \approx V_{\text{galaxy}}$

$$V_G = C_G \sqrt{\frac{E_{\text{vacuum}}}{E_{\text{dark}}}} \approx V_{\text{galaxy}} \sqrt{\frac{E_{\text{vacuum}}}{E_{\text{dark}}}}. \tag{81}$$

The calculation gives[9]

$$V_G \approx 2.8 \times 10^8 \sqrt{\frac{10^{113}}{10^{-9}}} \approx 2.8 \times 10^{69}\ \text{m/s}. \tag{82}$$

E. Isotropy and isothermy of the cosmic microwave background radiation (CMBR)

In his book "Dernières nouvelles du cosmos," Hubert Reeves writes on the cosmic microwave background radiation:[14]

"The temperature of the fossil radiation, measured by different telescopes, is practically the same in all directions of the sky. The observed deviations do not exceed three parts in a hundred thousand over the entire celestial sphere. This extraordinary isotropy carries valuable information on the state of the ancient universe: matter was extremely homogeneous and isothermal.

This almost perfect isothermal of the ancient cosmos is surprising to say the least. Why? Fossil radiation was emitted as the hydrogen atoms formed. At that time, the universe was three hundred thousand years old. The causal sphere of the particles emitting the fossil radiation then extended for three hundred thousand light years (in fact, a million light years because of the expansion). It covers only a tiny part of the contemporary sky. **Particles from different regions of the sky had never been in contact with each other at the time of this emission**.

The isothermal of the sky forces us to conclude: atoms located outside their sphere of mutual causation had, at that time, almost identical temperatures.

Hence the question: how (**by what physical influence**) could these atoms come into thermal unison? How to explain their thermalization beyond their sphere of causality?"

The theory of the DMR proposes that the Universe, from its origin, is bathed in a medium made up of entities moving at speeds much greater than that of light. Thus, it is these entities that would constitute the "physical influence," which explains the almost perfect isothermal of the cosmic diffuse background.

The particles of the different regions of the sky were in contact thanks to the gravitons.

F. Period of inflation after the Big Bang

In his book "A la recherche de l'univers invisible," David Elbaz, astrophysicist, writes about inflation:[15]

"Alan Guth, in his book 'L'Univers inflationnaire,'[16] describes his inflation theory that the entire universe emerged from a point that swelled faster than the speed of light. Guth's idea, concocted by Russian physicist Andrei Linde, assumes that a new kind of energy is causing space to expand exponentially. The space contained within the cosmological horizon doubled 173 times in a row, which corresponds to a factor of $2^{173} = 10^{52}$.

The inflation of the universe following the Big Bang, according to Guth, lasted a fraction of a second. A moment in which the universe went from an infinitely small size (10^{-52} m) just after the Big Bang (10^{-37} seconds) to that of a grapefruit in just 10^{-35} seconds.

The theory of inflation remains a hypothesis today because we would have to go back to the first moments after the Big Bang to have formal confirmation. The main difficulty brought by this theory consists in imagining the existence of a new form of energy which can cause the expansion of space, an expansion which accelerates over time because inflation supposes an exponential growth of the universe."

In the theory of the DMR, it is assumed that, at the time of the Big Bang, a huge number of gravitons were contained in an infinitely small volume, had zero translational velocity and maximum rotational velocity (gravitons total spin).

A slight interaction between a few gravitons triggered the Big Bang by transforming the gravitons-spin into standard gravitons (part of the speed of rotation transformed into the speed of translation while keeping constant the total energy of each graviton).

If we accept the theory of inflation that considers that the Universe went from 10^{-52} m to about 1 m ($\Delta d \approx 1$ m) in just $\Delta t = 10^{-35}$ s, then the speed (of translation) of gravitons went from zero to the following value at the end of inflation:

$$\mathrm{V}_G = \frac{\Delta d}{\Delta t} \approx 10^{35}\ \mathrm{m/s}. \tag{83}$$

If we take more precisely the scenario proposed by Alan Guth in which the universe has doubled N = 173 times in a row and we assume that the doublings in size have been regularly spaced in time by Δt/N, then the speed of gravitons doubled every time the universe doubled in size and during the last doubling in size the speed of gravitons finally reached the following value:

$$\mathrm{V}_G = \frac{\Delta d - \Delta d/2}{\Delta t/N} \approx 173\,\frac{1.0 - 0.5}{10^{-35}} \approx 10^{37}\ \mathrm{m/s}. \tag{84}$$

Gravitons could therefore explain the phenomenon of inflation proposed by Alan Guth and the "new form of energy" needed would be that of gravitons. (The initial rotational energy of gravitons converted in part into energy of translation.)

Within the framework of the theory of the DMR, it is assumed that gravitons travel on average the radius of the current universe in Planck's time

$$V_G \approx \frac{R_{\mathrm{Universe}}}{t_{\mathrm{Planck}}}\ \text{which gives:}\ V_G \approx \frac{13.7\times 10^9 AL}{5.4\times 10^{-44}} \approx 2.4\times 10^{69}\ \mathrm{m/s}. \tag{85}$$

The speed of translation of gravitons would have increased from 0 at the time of the Big Bang to 2.4×10^{69} m/s in the Universe today.

What should be remembered is that the prodigious speed of gravitons could explain the same important points as those explained by the inflation proposed by Alan Guth (current spatially flat universe, almost perfect isothermy and isotropy of the Cosmic Microwave Background Radiation, …).

The graviton could play a role equivalent to the "inflaton," hypothetical particle which would explain the inflation.

G. Circulation of gravitons in the Multiverse

The original gravitons would be those existing just before the Big Bang.

However, given the enormous speed of gravitons, they should have left our visible Universe after a relatively short time.

The explanation for an approximately constant number of gravitons in our Universe would be the existence of the Multiverse which is a hypothetical group of multiple Universes.

Therefore, it would be the existence of a very large number, even an infinite number of Universes, which would exchange gravitons between them, which would explain the presence of gravitons in our current Universe.

Given the size of our Universe and the distances between Universes, it is likely that the speed of gravitons must be much greater than the speed of light.

VIII. CONCLUSIONS

This article provides a demonstration of the formula for the acceleration of the flux of the medium in the **exterior** case which is: $\gamma_{\mathrm{flux}} = \mathrm{GM}/r^2$.

From this formula, we deduce the speed of the flux of the medium which is: $V_{\mathrm{flux}} = \sqrt{2\mathrm{GM}/r}$.

The article also provides a demonstration of the formula for the acceleration of the flux of the medium in the **interior** case which is: $\gamma_{\mathrm{flux}} = (\mathrm{GM}/R^3)r$.

From this formula, we deduce the speed of the flux of the medium which is

$$V_{\mathrm{flux}} = \sqrt{\frac{\mathrm{GM}}{R}\left(3 - \frac{r^2}{R^2}\right)}.$$

Also the universal constant of gravitation is given by the following formula:

$G = \frac{k_n}{4\pi}\frac{s_n}{m_n}(V_G - V_{\mathrm{Gspin}})$ containing the characteristics of the nucleons (s_n, m_n) and especially the characteristics of the gravitons (k_n, V_G, V_{Gspin}).

This formula shows that the universal gravitational constant is not a simple numerical value deduced from experimentation but has a much deeper origin based mainly on the characteristics of the gravitons themselves.

Another important point is that the gravitational acceleration, which is the acceleration of the flux of the medium, can be put in the form $\gamma_{\mathrm{flux}} = K\frac{N_b s_n}{r^2} = k_n.\Delta V_G \frac{N_b s_n}{4\pi r^2}$, where $K = \frac{k_n}{4\pi}(V_G - V_{\mathrm{Gspin}})$ is a constant depending only on the characteristics of the gravitons and their interaction with nucleons.

The formula for the gravitational acceleration does not contain mass but only the cross section s_n of a nucleon and the total number of nucleons N_b in the massive body. In this approach, we neglect the mass of electrons compared with that of atomic nuclei.

It should also be noted that the Newtonian gravitational potential ϕ is nothing else than the square of the velocity of the flux of the medium (up to a factor −2): $V_{\mathrm{flux}}^2 = -2\phi$.

The article also establishes a link between the theory of the DMR and general relativity.

Indeed, the fundamental quadratic form ds^2 (which is equivalent to the metric tensor) can be written in the case of a massive body without rotation and without electric charge

$$ds^2 = \sum_{i,j=0}^{3} g_{ij} dx^i dx^j = g_{00} c^2 dt^2 + g_{11} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta d\phi^2$$

$$\text{with } g_{00} = \left(\frac{dt_0}{dt}\right)^2 \equiv \left(\frac{T_0}{T}\right)^2 = 1 - \frac{V_{\text{flux}}^2}{c_0^2} \quad \text{and} \quad -g_{11} = \left(\frac{dl_0}{dr}\right)^2 \equiv \left(\frac{L_0}{L}\right)^2 = \left(1 - \frac{V_{\text{flux}}^2}{c_0^2}\right)^{-1}.$$

Finally, the article provides many arguments in favor of a speed of gravitons much greater than the speed of light.

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