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Contribution to the development of the theory with absorption of gravitational interaction[3]

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Abstract

In this paper it is investigated a hypothesis concerning the origin of the gravitational interaction. In accordance with this hypothesis, the gravitational interaction is due to the universal background radiation absorption. The Theory with Absorption of Gravitational Interaction (T. A. G. I.) is a development of the Newton idea concerning the origin of the gravitational interaction: the gravitation is generated by the impulse spread of any medium on whatever body.

Keywords: *classical theory of gravitation, universal background of radiation*

Introduction

The Theory with Absorption of Gravitational Interaction (T. A. G. I.) is a development of the Newtonian idea concerning the origin of the gravitational interaction [1]. In accordance with this idea, the gravitation is generated by the impulse spread of any medium on whatever body. The first estimation of this type of force was made by Le Sage [2]. In Le Sage's theory, medium is an ideal gas, and the force is generated by the screening of the flux of the particles of the gas. For two spherical bodies, Le Sage get a force proportional to the product of the areas of two spheres and

$$F \propto \frac{R_1^2 R_2^2}{r^2}. \tag{1}$$

A microscopics theories of this type was proposed by: K. C. Kar, A. K. Bhattacharyya [3], V. Buonamano, A. Engel [4], G. F. Cerofolini [5], and M. F. Podlaha [6]. In these models, the microscopic particles interact through agency of the screening of the subcuantic medium (ether model of physical vacuum). A Roumanian variant of this model was elaborated by I. Ioviţ Popescu [7].

A macroscopic theory of this type was proposed by I. A. Adămuţ. The Theory with Absorption of Gravitational Interaction or The Electro-Thermodynamical Theory of Gravitation (E. T. T. G.) [8] reaches the conclusion that the gravitational interaction is due to the universal background radiation (electromagnetic or/and gravitational nature) absorption, characterized by the intensity I_0, according to the Lambert-Beer law $I = I_0 \exp(-\rho\alpha x)$ (ρ is the mass density,

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[3] The paper was presented, in a first form, at Experimental Gravitational Symposium GE 2, Bucharest, 1982

x the thickness of the layer and α the absorption constant). Every point in the neighborhood of the body with mass M and radius R is characterized by a vector $\Delta\vec{I} = -\left(I_0 - I\right)\vec{r}/r$

$$\Delta\vec{I} = -\pi I_0 \frac{R^2}{r^2}\left[1 - \frac{1-\left(1+2\rho\alpha R\right)\exp\left(-2\rho\alpha R\right)}{2\left(\rho\alpha R\right)^2}\right]\frac{\vec{r}}{r} \cong -I_0\alpha\frac{M}{r^2}\left[1-\frac{3}{4}\rho\alpha R + ...\right]\frac{\vec{r}}{r}. \quad (2)$$

The vector $\Delta\vec{I}$ is assimilated with the intensity of the gravitational field generated by the absorption of universal radiation through the mass M. A probe body with mass m is acted upon with the force

$$\vec{F} = m\Delta\vec{I} = -I_0\alpha\frac{Mm}{r^2}\left[1-\frac{3}{4}\rho\alpha R + ...\right]\frac{\vec{r}}{r}. \quad (3)$$

The model of gravitational interaction proposed by E. T. T. G. [1] is asymmetric, because it ignores the absorption of the radiation by the probe body with mass m. This paper eliminates this asymmetry and investigates new hypotheses about universal radiation.

The Universal Radiation

In the Universe here exists a remanent (relict) background radiation like electromagnetic (microwave) background radiation type with $T = 2,7\mathrm{K}$. The intensity of this radiation is I_{0r} and the density is $w_{0r} = I_{0r}/4c$. The referential frame, respect to the background radiation is homogeneous and isotropic, is an absolute frame.

There is also an active homogeneous and isotropic background radiation. The intensity of this radiation is I_{0e} and the density is $w_{0e} = I_{0e}/4c$. This background radiation is generated from all the systems of Universe by emission and absorption of radiation. This radiation carried the energy with the c velocity. The emitted power is proportional to the mass of the system (body)

$$P_e = \varepsilon m \quad (4)$$

and constant ε is the specific power.

The intensity of this radiation at the distance r of the body with mass m is

$$I_e(m,r) = \frac{P_e}{4\pi r^2} = \frac{\varepsilon m}{4\pi r^2}. \quad (5)$$

In the system, in rest with the absolute frame, the stationary absorbed radiation (the absorption power P_a) and the emitted (the emitted power P_e) radiation are equal, i.e.

$$P_e = P_a \quad (6)$$

The calculation of the intensity of background radiation

Let us consider a homogeneous and isotropic infinite model universe, at the cosmic scale, having the density ρ_0. According with the fig. 1, intensity I_{0e} is calculated in the

point O in the direction Oz. The intensity is generated by all the sources found in the infinite volume. The intensity generated by the mass $dm = \rho dV = \rho r^2 dr \sin\theta\, d\theta\, d\varphi$ in the point O is partial absorbed by the mater

$$dI_e(\varepsilon,\alpha,r) = dI_e(r)\exp\left(-\rho_0\alpha r\right) = \frac{\varepsilon dm}{4\pi r^2}\exp\left(-\rho_0\alpha r\right). \tag{7}$$

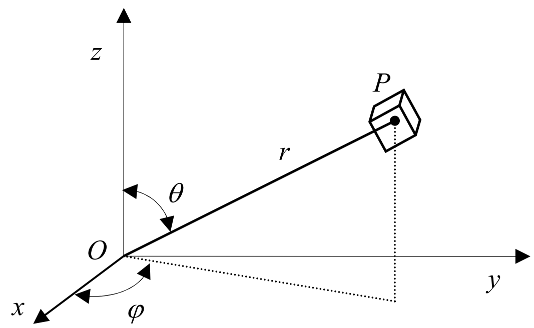

Fig. 1

The intensity in the Oz direction is

$$I_{0e} = \int dI(\varepsilon,\alpha,r)\cos\theta = \frac{\varepsilon\rho_o}{4\pi}\int_0^{\infty}\left[\exp\left(-\rho_0\alpha r\right)\right]dr\int_0^{\pi/2}\cos\theta\sin\theta d\theta\int_0^{2\pi}d\varphi = \frac{\varepsilon}{4\alpha}. \tag{8}$$

The intensity in the opposite direction is equal. The total intensity is zero: i.e. stationary background. The energy density of active background radiation is

$$w_{0e} = \frac{\varepsilon}{c\alpha}. \tag{9}$$

The energy intensity and density of the active background radiation is finite and depends on the two constants: the specific power and the absorption constant.

The Interaction Force between Two fixed Bodies

The intensity in the neighborhood of a body is r dependent, because of the absorption of the background radiation, and orientated to the body

$$\vec{I}(m,r) = -I_0\frac{R^2}{r^2}\left[1-\frac{1-\left(1+2\rho\alpha R\right)\exp\left(-2\rho\alpha R\right)}{2\left(\rho\alpha R\right)^2}\right]\frac{\vec{r}}{r} \cong -I_0\alpha\frac{m}{\pi r^2}\left[1-\frac{3}{4}\rho\alpha R+....\right]\frac{\vec{r}}{r}, \tag{10}$$

if $2\rho\alpha R \ll 1$. Because, at equilibrium, the absorbed power is equal to the emitted power, it results that the intensities at the r distance are equal. If in eq. (10), intensity I_0 is the intensity of the active background I_{0e}, the intensity $I(m,r)$ became the emitted intensity $I_e(m,r)$ given by the eq. (5). Because of this, further on, for estimation the interaction force between two bodies use only the absorption of the relict background radiation ($I_0 = I_{0r}$). Let there be two bodies with masses m_1 and m_2, radii R_1 and R_2, densities ρ_1 and ρ_2 (fig. 2).

One body interact with the other by the reciprocally absorption. In a point P, the body O_1 determines an intensity

$$\begin{aligned} I_{12}(r_P) = I_0\frac{R^2}{r_P{}^2}\frac{1-\left(1+2\rho_1\alpha R_1\right)\exp\left(-2\rho_1\alpha R_1\right)}{2\left(\rho_1\alpha R_1\right)^2}\exp\left(-2\rho_2\alpha x\right) = \\ I_0\frac{R^2}{r_P{}^2}A_1\exp\left(-2\rho_2\alpha x\right), \end{aligned} \tag{11}$$

because of the attenuation in the body O_2 an interval $PC = x$. In the opposite direction, the remanent background determines an intensity

$$I_{012} = \frac{I_0 R_1^2}{r_P^2} \exp\left[-\rho_2 \alpha \left(d - x\right)\right]. \tag{12}$$

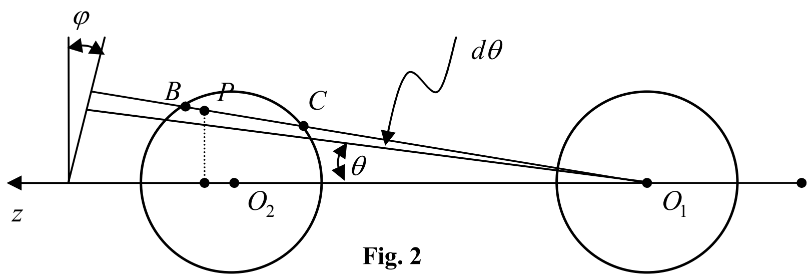

Fig. 2

In a point P, a layer of thickness dx will determine an attenuation of intensities

$$dI_{12}(r_P) = -I_{12}(r_P)\rho_2 \alpha dx = -I_0 \frac{R^2}{{r_P}^2} A_1 \rho_2 \alpha \exp\left(-2\rho_2 \alpha x\right) dx, \tag{13a}$$

$$dI_{012} = I_{012}\rho_2 \alpha dx = \frac{I_0 R_1^2}{r_P^2} \rho_2 \alpha \exp\left[-\rho_2 \alpha \left(d - x\right)\right] dx. \tag{13b}$$

The forces exercised by the two intensities about the elementary area $d\sigma = r_P^2 \sin\theta d\theta d\varphi$, at point P, is in opposite direction. The net force is

$$dF = \frac{\left(dI_{012} - dI_{12}\right)}{c} d\sigma. \tag{14}$$

The net component in the Oz direction is

$$dF_z = dF \cos\theta = \frac{\left(dI_{012} - dI_{12}\right)}{c} \cos\theta d\sigma. \tag{15}$$

Substituting eqs. (13) in eq. (15) and integrating we obtain

$$\vec{F}_z = -\frac{\pi^2 I_0 R_1^2 R_2^2}{c}\left(1 - A_1\right)\left[1 - \frac{1 - \left(1 + 2\rho_2 \alpha R_2\right)\exp\left(-2\rho_2 \alpha R_2\right)}{2\left(\rho_1 \alpha R_1\right)^2}\right]\frac{\vec{r}}{r^3}, \tag{16a}$$

$$\vec{F}_z = -\frac{\pi^2 I_0 R_1^2 R_2^2}{c}\left(1 - A_1\right)\left(1 - A_2\right)\frac{\vec{r}}{r^3}. \tag{16b}$$

In the situation when $2\rho_1 \alpha R_1 << 1, 2\rho_2 \alpha R_2 << 1$, the expression of the force became

$$\vec{F} \cong -\frac{\alpha^2 w_0}{4} \frac{m_1 m_2}{r^2}\left(1 - \frac{3}{4}\rho_1 \alpha R_1 + ...\right)\left(1 - \frac{3}{4}\rho_2 \alpha R_2 + ...\right)\frac{\vec{r}}{r}. \tag{17}$$

In accordance with the eqs. (16) and (17), the expression of the gravitational force is symetrised regarding the two bodies parameters. Comparing this expression to the Newtonian expression $\vec{F}_N = -(Gm_1 m_2)(\vec{r} / r^3)$, it results:

a) a dependence of the gravitational constant both the universal parameters(α, w_0)

and the parameters of two bodies (ρ, R)

$$G \cong \frac{\alpha^2 w_0}{4}\left(1-\frac{3}{4}\rho_1\alpha R_1+...\right)\left(1-\frac{3}{4}\rho_2\alpha R_2+...\right), \tag{18}$$

or

b) an independent gravitational constant $G=\frac{\alpha^2 w_0}{4}$ and the gravitational mass (active gravitational mass m_{1a} and passive gravitational mass m_{2p}) depend on the absorption

$$m_{1a} \cong m_1\left(1-\frac{3}{4}\rho_1\alpha R_1+...\right), \quad m_{2p} \cong m_2\left(1-\frac{3}{4}\rho_2\alpha R_2+...\right). \tag{19}$$

Therefore, the interaction forces between two bodies depend not only on the mass bodies but also on their nature.

The Action of Radiation upon a Body in Motion

The development of the theory of gravitational interaction based on the universal background radiation implies also the approach to a system of two bodies, one of which is in a motion as related to the radiation. Let it be a body of radius and density which moves rectilinearly and uniformly at the speed as related to the radiation. According to the inertial frame equivalency, we can consider the body at rest and radiation having a supplementary motion at the speed. The theory of relativity gives the following expression for the vector Poynting and the energy density of a source moving at the speed υ

$$S=S_0\frac{1-\frac{\upsilon^2}{c^2}}{\left(1-\frac{\upsilon\cos\theta}{c}\right)^2}, \quad w=\frac{S}{c}=w_0\frac{1-\frac{\upsilon^2}{c^2}}{\left(1-\frac{\upsilon\cos\theta}{c}\right)^2}. \tag{20}$$

In the approximation $\upsilon << c$, the expression of the energy density became

$$w(\theta) \cong w_0\left(1+\frac{\upsilon\cos\theta}{c}\right)^2. \tag{21}$$

The absorbed universal background radiation being anisotropic, it determines a force upon the body

$$dF = w_{abs.}(\theta)2\pi R^2\sin\theta\, d\theta = w(\theta)\left[1-\exp(-2\rho\alpha R)\right] \cong w(\theta)4\pi R^2\rho\alpha\sin\theta\, d\theta. \tag{22}$$

The component parallel to the direction of motion is $dF_{//}=dF\cos\theta$. Inserting the eq. (22), it results

$$F_{//}=\int_0^{\pi} dF\cos\theta=\frac{8\pi R^3\rho}{3}\frac{\alpha S_0}{c}\frac{\upsilon}{c}=P_a\frac{\upsilon}{c^2}=F_a, \tag{23a}$$

$$\frac{8\pi R^3\rho\alpha S_0}{3}=2m_p\alpha S_0=P_a. \tag{23b}$$

The radiation acts with a force opposed to the motion and which is proportional to the speed. In order to maintain the body in uniform motion, an equal force of the opposite direction must act and a power must be transmitted

$$P = F_{//}\upsilon = P_a \left(\frac{\upsilon}{c}\right)^2 . \quad (24)$$

To increase the speed, the force greater than that due to the absorber radiation must act. Since the body in accelerated motion emits an anisotropic radiation, therefore an emitted radiation force is also exercised F_e. The force owing to the radiation emitted in the approximation $\upsilon << c$ has the expression

$$F_e = P_e \frac{\upsilon}{c^2} . \quad (25)$$

and the total force is

$$F = F_a + F_e + m_i \frac{d\upsilon}{dt} , \quad (26)$$

with m_i inertial mass. Substituting eqs. (23, 24 and 25) in eq. (26), it results

$$F = \left(P_a + P_e\right)\frac{\upsilon}{c^2} + m_i \frac{d\upsilon}{dt} . \quad (27)$$

Comparing eq. (27) to the relativistic expression of the force $F = (dm_i / dt)\upsilon + m_i(d\upsilon / dt)$, we obtain

+(28a)

or

$$m_i = \frac{E_{ext.}}{c^2} \quad (28b)$$

The expression (28) confirms quantitatively the hypothesis [9] that the inertial mass is proportional to the energy exchanged by the body (system) with the Universe (the exterior of the body). Since the gravitational interaction is also due to this exchange of energy, it follows that mass as a property of the body to absorb and emit energy, comprising both the inertia properties m_i and the property of attracting another mass m_a and the property of passive mass m_p. If the motion is uniform, the emitted power is equal to the absorbed power (the stationary state) and exterior interaction energy of the body is $P_a\tau$. Substituting this expression and eq. (23b) in eq. (28), we obtain

$$m_i = \frac{2m_p \alpha S_0 \tau}{c^2} . \quad (29)$$

In accordance with the equivalence principle, $m_i = m_a = m_p$ and of the eq. (29), we obtain

$$\tau = \frac{c^2}{2S_0\alpha} = \frac{1}{2\rho_0 \alpha c} \cong \frac{R_0}{c} . \quad (30)$$

Since $1/\rho\alpha$ has the meaning of the distance for which the radiation intensity decreases $e \cong 2,7$ times, we interpreted τ as the time during which a body interacts with the matter in a sphere with radius $R_0 = 1/2\rho\alpha$. Therefore, in the case of an infinite model of universe, a body, due to the exponential absorption, interacts only with a finite number of other bodies found in a sphere with the radius R_0 and with its centre in the body.

Conclusion

In this paper, we naturally introduced the forces of interaction between two masses as being due to the reciprocally absorption of the universal background radiation. The expression (17) obtained for the forces point out the fact that under the condition $2\rho\alpha R << 1$ the gravitational interaction depends on the bodies' nature. Experimentally, it is equivalent to the fact that the measurements of the gravitational constant G will depend on the substance of the bodies to be tested. Considering the system of the bodies as having the same mass but of different substances, it results

$$\frac{G_n}{G_k} = \frac{F_n}{F_k} = \left(\frac{1-3\rho_n R_n \alpha/4}{1-3\rho_k R_k \alpha/4}\right)^2 \cong \left(\frac{1-3\alpha\sqrt[3]{m\rho_n^2}/4}{1-3\alpha\sqrt[3]{m\rho_k^2}/4}\right)^2 . \tag{31}$$

The relation (31) demonstrates that if $\rho_n > \rho_k$, it results $G_n < G_k$. This dependence is verified by the experiments made by G. Pontikis [10]:

$\rho_{Cu} = 8{,}910^3\ \mathrm{kgm^{-3}}$, $G_{Cu} = (6{,}67198 \pm 0{,}0004)10^{-11}\,\mathrm{Nm^2kg^{-2}}$;

$\rho_{Ag} = 10{,}510^3\ \mathrm{kgm^{-3}}$, $G_{Ag} = (6{,}67197 \pm 0{,}0004)10^{-11}\,\mathrm{Nm^2kg^{-2}}$;

$\rho_{Pb} = 11{,}310^3\ \mathrm{kgm^{-3}}$, $G_{Pb} = (6{,}67188 \pm 0{,}0005)10^{-11}\,\mathrm{Nm^2kg^{-2}}$.

The ideas presented here will be further developed in the future paper for the case of dependence of the absorption constant α of the frequency of radiation.

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Contribuţii la dezvoltarea teoriei cu absorbţie a interacţiunii gravitaţionale

Rezumat

În această lucrare se investighează o ipoteză privind originea interacţiunii gravitaţionale. În concordanţă cu această ipoteză, interacţiunea gravitaţională este determinată de absorbţia unui fond de radiaţie universală. Teoria interacţiunii gravitaţionale cu absorbţie (T. I. G. A.) este o dezvoltare a ideii lui Newton privind originea interacţiunii gravitaţionale: gravitaţia este generată prin împrăştierea impulsului unui mediu oarecare de către un corp oarecare.