# Exact Formula for Shadow-Gravity, Strong Gravity

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**Abstract.** A new, more exact than that recently be published, ( Apeiron, Vol. 18, No 2 (2011)), the formula for Shadow-Gravity force, for any distances between fundamental sub-particles, including very short ones, when gravitation becomes strong, is developed. Basic problems because of which old Fatio-Lesage's idea of gravitation has not been recognized are discussed. Expression and numerical data for the strong gravitation are given. Beginning from distances $10^{-35}$ m the gravitation force becomes in 40 times larger than its usual macroscopic value and in $10^{41}$ times larger for the distance ~$10^{-54}$ m. Numerical evaluations of the fations gas energy density ($\varepsilon_G = 5.0445\times10^{109}$ J/m$^3$), of gravitational cross-section of the electron ($\sigma_{eG} = 3.2827\times10^{-69}$ m$^2$), and basic parameters of the shadow gravity are made. It is shown that a usual substance absorbs hypothetical fations very weakly. The absorption probability is ~$10^{-42}$.

*Keywords:* Shadow-gravity, strong gravity, exploding electron, hypothetical sub-particles.

## 1. Introduction.

As far as I know, the first time a formula for the shadow gravity force was obtained by Darwin in 1905 [1]. He is considered the alleged case where the hypothetical " ultramundane corpuscles " (fations in our terminology) ) impact the bodies partially elastically with some coefficient k, which is 1 for a complete inelasticity, and 2 for perfect elasticity. Darwin do not taken into account fations that reflected between FSPa and FSPp. Finally obtained by him formula is valid only for k = 1 and perfect smoothness; it has the form

$$\frac{1}{4}\pi\rho\frac{\mathrm{v}^2 a^2 b^2}{R^2}, \tag{1}$$

where (in original denotation) $\rho$ is a mass density of the fations gas, $\mathrm{v}$ is the fation velocity, $a$ and $b$ are radii of spherical particles of interacting bodies, $R$ is the distance between them.

If impact of each single fation takes place independently from others and it is either absorbed or reflected in a random manner, then we can consider action of elastic and inelastic blows separately.

In [2] I have found analogous formula (by a method differing from Darwin's one), using the notion about a *shadow area*. It has the form

$$F_{G1} = \frac{\pi r_c^4 \varepsilon_G \delta}{4\,\ell^2}, \tag{2}$$

where $r_c$ is the radius of active and passive fundamental sub-particles (core of the electron in this case) of interacting bodies, providing that their radii have the same values; $\delta$ is the factor, which has the meaning of the probability absorbing fations by fundamental sub-particles (*FSP*). I introduced also notion of energy density $\varepsilon_G$ of the fation gas instead of Darwin's $\rho\,\mathrm{v}^2/2$, and considered impacts with perfect smoothness.

In [3] I have found the more exact (although not enough exact) formula as

$$F_{Gff} = \frac{\left(2-\delta_p\right)\pi\, r_p^2\, r_a^2\, \varepsilon_G \delta_a}{4L^2} k\left(L\right). \tag{3}$$

where $\delta_a$ and $\delta_p$ are the asymmetry factors for active and passive FSPs, respectively, $k(L)$ is the factor, which for macroscopic conditions, when *L*>>*r*, is equal to 1 and for short distances it becomes very large, and gravitation becomes strong.

Finally, in [4], I have found the more exact formula as

$$F_{Gff} = \frac{\pi\ \varepsilon_G r_p^2 r_a^2 \delta_a}{4R^2} k\left(R^* \delta_a\right). \tag{4}$$

This formula really is exact, but derivations need to be some clarified. In this version of paper we will make required improvements.

In [3] I have introduced the notion about *fundamental sub-particles* (FSP) from which all substance consists. I suggest to consider as fundamental such sub-particles, which are *absolutely impenetrable* for fations. Evidently FSP, to a certain extent, can be associated with known sub-leptons: preons, which are hypothetical constituents of the electron and quarks.

## 2. Updated formula for the shadow-gravity force

### 2.1. Component of the force from the action of inelastic collisions

Let us consider the (as it was done in [3]) gravitational interaction between two FSPs (Fig 1a). For convenience, the FSP which creates a gravitational field (making the shadow from fations) will be here referred to as the active FSP (FSPa), and the FSP to which the gravitational force is attached ( is shadowed from fations) will be referred to as the passive one (FSPp).

In the same manner as in [3] we consider that the gravitational force is proportional to the total area of the shadow falling on the cross-section of the passive FSP from the active one. Let us name it as *Gravitational Cross-section* (*GCr-S*). Gravity effect be possible only if fations are absorbed by bodies (by FSPs in the final analysis). As Darwin noted [1], the attraction effect vanishes, when fations bombard bodies fully elastically, because fations that reflected between FSPa and FSPp, in the case of fully elastic collisions, exactly counterbalance the attraction. However, it is so only if *all* fations impact bodies elastically. We will show in this paper that elastic collisions also make a contribution in gravity, if a part of fations have inelastic collisions. I have introduced [2] some probability factor $\delta$ of inelastic collision of fatons with FSPs, which *is the ratio of the part of the fations absorbed by FSP to the all fations bombarding FSP.*

As distinguished from Darwin we will consider that part of fations impacts, with some probability, $\delta$, in fully inelastic way and other part, $(1-\delta)$, impacts in fully elastic way. The effects of elastic and inelastic impacts will be considered separately and then be summed.

In the same manner as in [3] let us consider two FSPs: passive *p* and active *a* (Figure 1a). The passive FSP*p* is shadowed, from the right, by the active FSP*a* from the flows of fations 2 directed within the limits of the solid angle element $d\Omega$ of the solid angle $\Omega$ (unidirectional flows having energy density $\varepsilon_G^*$). Therefore only flows 3, reflected from FSP*a*, fall on the FSP*p* under the plane angle $\Omega_p$, from the right side. These flows have energy density $\varepsilon_G^*(1-\delta_a)$, because FSP*a* absorbed a part of fations proportionally to the factor $\delta_a$, therefore these flows act on the FSP*p*, from the right side, with the force horizontal projection of which is proportional to $\varepsilon_G^*(1-\delta_a)\delta_p \cos\Omega_p$. We introduced here different indexes *p* and *a* at $\delta$ in case where passive and active FSP have different value of asymmetry factors. In opposite direction (from the left side), flows 4 also act with force proportional to $\varepsilon_G^* \delta_p \cos\Omega_p$.

It may be noted that, for the inelastic collisions, a necessity to resolution of the momentum into radial and tangential components is fall away.

In addition, we must take into account the fact that not all fations, which arrive from the left side, fall on the FSP*a* and then, being reflected from FSP*a*, fall on the FSP*p* from the right side, inasmuch as FSP*p* screens some part of them, therefore it is necessary to introduce a coefficient $\left[1-\mathrm{k}\left(R^*\right)\right]$ for the fations falling on the FSPp from the right side. We denote $R^* = R / r_p$, where *R* is distance between

FSPs, and $r_p$ is radius of FSPp. Thus, resultant force, which acts on the FSP*p* in direction to FSPa is proportional to

$$\varepsilon_G^* \left\{ \delta_p - \delta_p (1-\delta_a) \left[ 1\text{-k}\left( \mathrm{R}^* \right) \right] \right\} \cos \Omega_p = \varepsilon_G^* \delta_a \delta_p \left[ 1 + \mathrm{k}\left( \mathrm{R}^* \right) \left( \frac{1}{\delta_a} - 1 \right) \right] \cos \Omega_p \tag{4}$$

where

$$k\left( R^* \right) = \frac{\Omega_s}{\Omega_f + \Omega_s}, \tag{5}$$

where $\Omega_f$ is the solid angle within limit of which fations freely fall on FSPa and then, being reflected from FSP*a*, fall on the FSP*p* from the right side, and $\Omega_s$ is the solid angle screened by FSPp. The vertex of all these angles is in the center *A* of the active FSPa (Figure 1(a)). Figuratively speaking, $\Omega_s$ is the solid angle under which FSPp is seen from the centre *A*. It is equal to [3]

$$\Omega_s = \frac{S_{rp}}{\rho^2} = 2\pi \left( 1 - \sqrt{1 - \left( \frac{r_p}{R} \right)^2} \right), \tag{6}$$

where $S_{rp}$ is the area of the spherical surface having radius $\rho$.

After substituting (6) in (5) we obtain

$$k\left( R^* \right) = 1 - \sqrt{1 - \left( \frac{r_p}{R} \right)^2}. \tag{7}$$

In doing so, we accept $\Omega_f + \Omega_s \approx 2\pi$ without regard the difference in radii of FSPs. Although the value (7) is approximate, but according to our calculations it is very slightly differs from the exact one. We do not give exact calculations here because they are extremely cumbersome.

As was noted above, gravitational effect is proportional to the shadow, which falls on the passive FSP*p* from the active FSP*a* with taking into account above features connected with fations being reflecting from the FSPa. Actions of all other fations, that bombard the FSP*p* from right and left sides, counterbalance each other.

Thus, the cross-section element $\sigma$ (in Figure 1(b) it is shaded), is shadowed from the fations directed within the limits of the element $d\Omega$ of the solid angle $\Omega$. Total area of the shadow is equal to sum of the elements $\sigma$, when the center $C_s$ of the shadow (Fig. 1a) circumscribes the circle with radius $a\cos\Omega_p$ and the plane angle $\Omega_p$ goes through the values from 0 (when *a*=0) to $\Omega_{p\max}$, when $a = r_a + r_p$. In doing so, the solid angle $\Omega$ goes through the values from 0 to $\Omega_{\max}$. Thus, considering (4) the force acting on the total shadow area in the direction to FSP*a* is equal to

$$F_{Gff} = \varepsilon_G^* \delta_a \delta_p k\left( R^*, \delta_a \right) \int_0^{\Omega_{\max}} \sigma \cos \Omega_p \, d\Omega, \tag{8}$$

where we denoted

$$k\left( R^*, \delta_a \right) = 1 + \mathrm{k}\left( \mathrm{R}^* \right) \left( \frac{1}{\delta_a} - 1 \right). \tag{9}$$

Next from Figure 1(b)) we find [3]

$$EF = r_p \sin(\varphi_p / 2) = r_a \sin(\varphi_a / 2). \tag{10}$$

The cross-section element of the shadow $\sigma$ can be found as the sum of the areas of segments:

$$\sigma_a = (1/2) r_a^2 \left( \varphi_a - \sin \varphi_a \right) \text{ and } \sigma_p = (1/2) r_p^2 \left( \varphi_p - \sin \varphi_p \right), \tag{11}$$

whence, taking into account (10), we obtain [3]

$$\sigma = \sigma_a + \sigma_p = \frac{r_p^2}{2} \left\{ \gamma_a^2 \left( \varphi_a - \sin \varphi_a \right) + 2 \left[ \arcsin\left( \gamma_a \sin \frac{\varphi_a}{2} \right) - \gamma_a \sin \frac{\varphi_a}{2} \sqrt{1 - \gamma_a^2 \sin^2 \frac{\varphi_a}{2}} \right] \right\} = \frac{r_p^2}{2} f_1\left( \varphi_a \right), \tag{12}$$

where and further $\gamma_a = r_a / r_p$, $r_p$ and $r_a$ are radii of the FSP*p* and FSP*a* respectively, $r_a \le r_p$. The expression in curly brackets is denoted by $f_1(\varphi_a)$. It will be used further.

The solid angle $\Omega$ is equal to ratio of the spherical segment area, $S_s$, to $\rho^2 = R^2 - a^2$, where $R$ is the distance between FSPs . The segment area, $S_s$, is based on the circle having the radius $a\cos\Omega_p$, where $a = CC_s$ (Fig. 1a).

It is obvious that [3]

$$\cos\Omega_p = \left[1 - \left(\frac{a}{R}\right)^2\right]^{1/2}. \tag{13}$$

The specified value of the spherical segment area is equal to

$$S_s = 2\pi\rho h, \tag{14}$$

where $h$ is the height of the segment, which is equal to

$$h = \rho\left(1 - \cos\Omega_p\right) = \rho\left(1 - \sqrt{1 - \left(a/R\right)^2}\right). \tag{15}$$

Then substituting last equation in (14) we obtain the expression for the solid angle as

$$\Omega = \frac{S_s}{\rho^2} = 2\pi\left\{1 - \left[1 - \left(\frac{a}{R}\right)^2\right]^{1/2}\right\}. \tag{16}$$

By differentiating this relationship with respect to $a$, we obtain [3]

$$d\Omega = \frac{2\pi a}{R^2 \cos\Omega_p} da. \tag{17}$$

From simple trigonometric relations (Fig. 1(b)), taking into account also (10), we obtain [3]

$$a = r_p \cos\left(\varphi_p/2\right) + r_a \cos\left(\varphi_a/2\right) = r_a\left\{\gamma_p\left[1 - \gamma_a^2 \sin^2\left(\varphi_a/2\right)\right]^{1/2} + \cos\left(\varphi_a/2\right)\right\} = r_a a', \tag{18}$$

where $\gamma_p = r_p/r_a = 1/\gamma_a$. The expression in curly brackets is denoted by $a'$.

By differentiating (18) with respect to $\varphi_a$, we obtain [3]

$$da = -\frac{r_a}{2}\left\{\frac{\gamma_a \sin\varphi_a}{2\left[1 - \gamma_a^2 \sin^2\left(\varphi_a/2\right)\right]^{1/2}} + \sin\left(\varphi_a/2\right)\right\} d\varphi_a = -\frac{r_a}{2} f_2\left(\varphi_a\right) d\varphi_a, \tag{19}$$

where expression in curly brackets is denoted by $f_2(\varphi_a)$.

Now, substituting (12, 17) into (8), taking into account also (18, 19), we obtain the formula for the component of the force from inelastic collisions as

$$F_{Gff}^{inelast} = \frac{\pi\, r_p^2 r_a^2 \varepsilon_G \delta_a \delta_p}{4R^2} k\left(R^*, \delta_a\right)\left(Int1 + Int2\right), \tag{20}$$

where $\varepsilon_G = 4\pi\varepsilon_G^*$ is the volume energy density of omnidirectional flows of fations, and

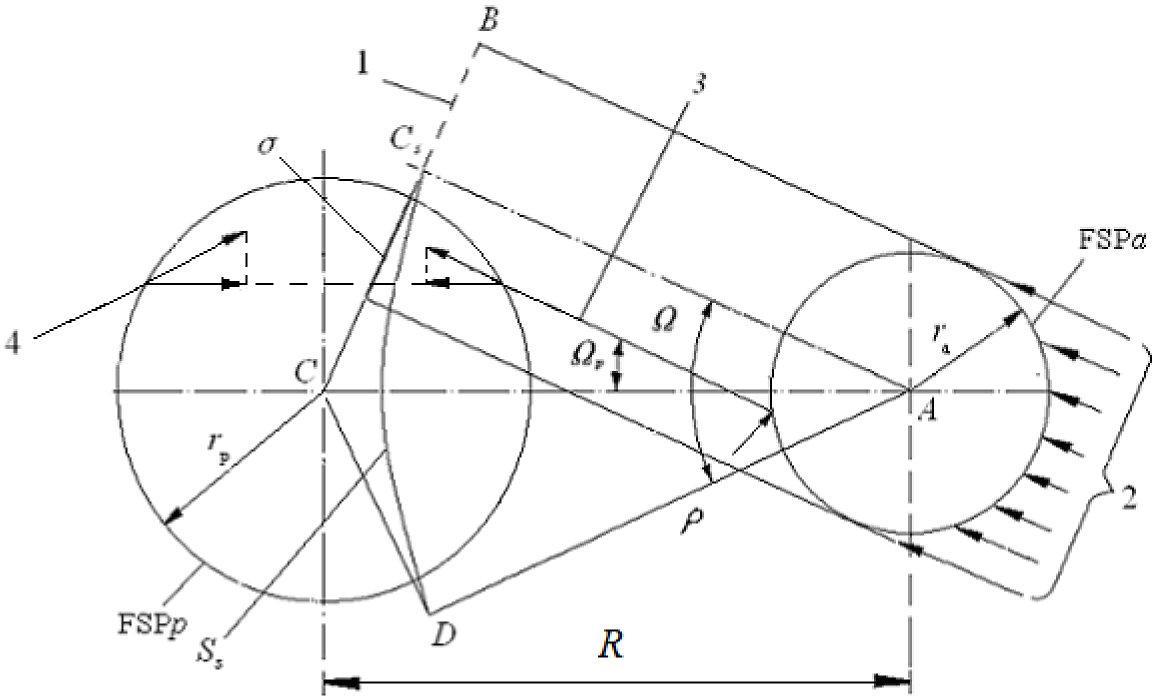


**Figure 1(a).** Scheme for calculation of the shadow-gravity force, affecting the FSP*p*. The passive FSP*p* is shadowed, from the right side, by the active FSP*a* from the flows of fations 2 directed within the limits of the solid angle element $d\Omega$ of the solid angle $\Omega$ (unidirectional flows having energy density $\varepsilon_G^*$). Only flows 3, reflected from FSP*a*, fall on the FSP*p* under a plane angle $\Omega_p$, from the right side. Analogous flows 4 acts from the left side. The difference of projections on the line AC force elements created by these flows pushes FSPp to FSPa.

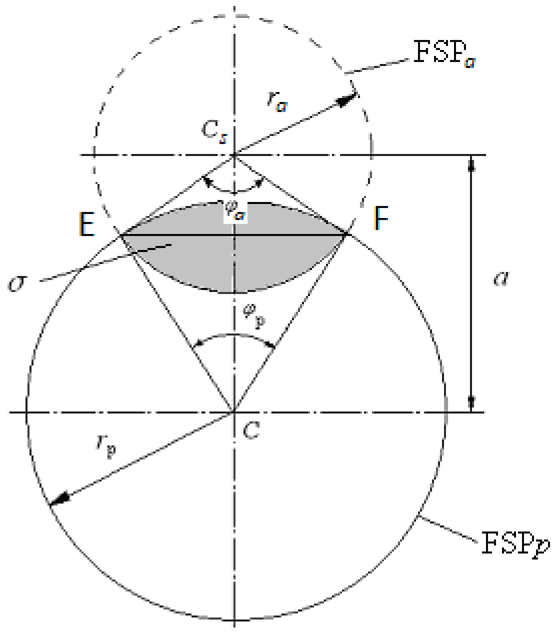


**Figure 1(b).** Cross-section on BCD (figure 1a). The force element is proportional, in modulo, to the area of the shadow element, $\sigma$, that falls on the cross-section BC of the passive FSP*p* from the active FSP*a* (Figure (1a)). $C_s$ is the shadow center; $r_a$ and $r_p$ are radii of active and passive FSPs.

$$I_{inelast} = Int1 + Int2 = \int_{2\pi}^{0} \frac{a' f_1(\varphi_a)\left[-f_2(\varphi_a)\right]}{2\pi}\, d\varphi_a + \frac{2}{r_p^2}\int_{0}^{r_p - r_a} a\, da = 1 \qquad (21)$$

are integrals, which were calculated by using expressions for two limits of integrating [3]. The first of them is equal to $2\pi, 0$, for the variable $\varphi_a$ that corresponds to positions of the shadow in the limits: $r_p - r_a \le a \le r_p + r_a$. The second limits are $0 \le a \le r_p - r_a$, for the variable $a$ and $\sigma = \pi r_a^2$ instead of (12). The first integral is for situation when FSPp is partially shadowed (like the waning moon) as depicted in Fig. 1b, and second for cases when the shadow from FSPa is wholly situated within the cross-section of FSPp . Result (21) is valid for any distances between FSPs and ratios of their radii, $r_a / r_p \le 1$. Thus, the formula (20) becomes as

$$F_{Gff}^{inelast} = \frac{\pi\ r_p^2\ r_a^2\ \varepsilon_G \delta_a \delta_p}{4R^2} k\left(R^*, \delta_a\right). \tag{22}$$

New formula substantially differs from (3), but we must take into account also a contribution of the elastic collisions. At first sight, it was necessary to expect, that elastic collisions gives the zero contribution. However, as we will show below, this is the case only if *all* fations bombard bodies elastically.

## 2.2. Component of the force from the action of elastic collisions

Flows of fations falling onto FSPp from the left side, taking part only in elastic collisions, have energy density $\left(1-\delta_p\right)\varepsilon_G^*$, and those coming from the right side after their reflecting from FSPa have energy density $\left(1-\delta_p\right)\left(1-\delta_a\right)\left[1-k\left(R^*\right)\right]\varepsilon_G^*$, where $\left(1-\delta_a\right)$ is factor considering the absorption of fations by FSPa, and $k\left(R^*\right)$ is given by (7) factor considering part of fations shadowed by FSPp.

In this case we must resolve the momentum vector on radial and tangential components, but taken into account only the radial component, because the tangential component is removed by the reflected fations (Fig. 2a). We assume that friction is absent in collisions.

Thus, the element of force

$$dF_{left} = 2\varepsilon_G^*(1-\delta_p)\rho\varphi_p \cos^2\left(\Omega_p + \alpha\right) dx d\Omega \tag{23}$$

acts on the arcwise element $\rho\varphi_p dx d\Omega$ (Fig. 2b ) of the FSPp cross-section in directions parallel to AC from the left side, and the element of force, which is proportional to

$$dF_{right} = 2\varepsilon_G^*\left(1-\delta_p\right)\left(1-\delta_a\right)\left[1\text{-k}\left(\text{R}^*\right)\right]\rho\varphi_p \cos^2\left(\Omega_p + \alpha\right) dx d\Omega, \tag{24}$$

acts on the analogous element from the right side. Here $\rho\varphi_p dx$ is the element of shadow area which falls on the FSPp from FSPa; $\rho = abs\left(x\right)$; $d\Omega$ is the element of the solid angle which we have obtained above (17). Others denotations are clear from the drawing. We have taken into account that radial component of the element force is proportional to $\rho\varphi_p \cos^2\left(\Omega_p + \alpha\right) dS d\Omega$ [5] and that $dS = dx / \cos\alpha$, where *dS* is the element of the surface area of $FSP_p$.

The resultant force element is

$$dF = dF_{left} - dF_{right} = 2\varepsilon_G^*\left(1-\delta_p\right)\delta_a \left[1\text{+k}\left(\text{R}^*\right)\left(\frac{1}{\delta_a} - 1\right)\right]\rho\varphi_p \cos^2\left(\Omega_p + \alpha\right) dx d\Omega. \tag{25}$$

Thus, the total formula for the gravitation force from elastic collisions will be as

$$F_{Gff}^{elast} = \int_{\Omega_1}^{\Omega_{\max}} \int_{a-r_a}^{r_p} dF_1 + \int_0^{\Omega_1} \int_{a-r_a}^{a+r_a} dF_2, \tag{26}$$

where $\Omega_1$ corresponds to coordinate $a_1 = r_p - r_a$, and $\Omega_{\max}$ to the coordinate $a_{\max} = r_a + r_p$ (Fig.2b); the first double integral and the element of force $dF_1$ correspond to situation when FSPp is partially shadowed as depicted in Fig. 2b and the second double integral and $dF_2$ are for cases when the shadow from FSPa is wholly situated within the cross-section of FSPp.

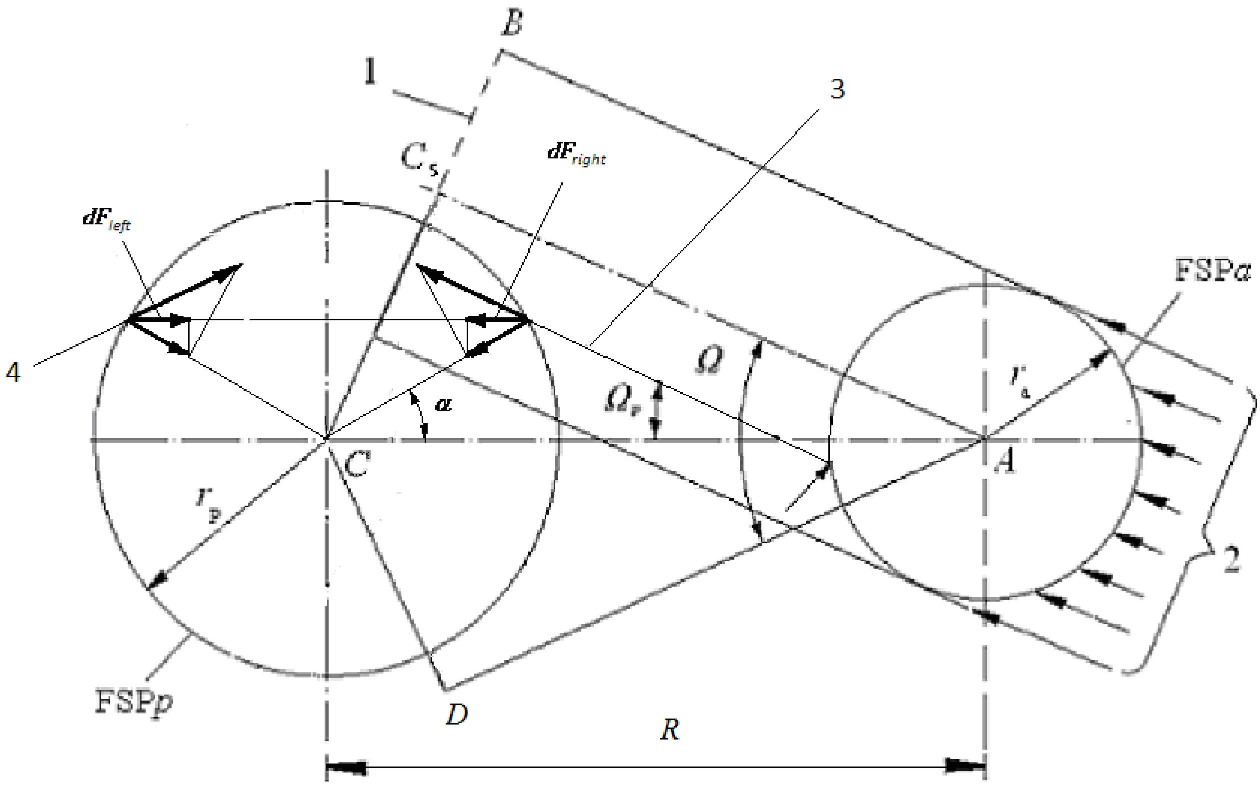


**Figure 2(a).** Scheme for calculation of the shadow-gravity force, affecting the FSP*p* by elastic collision. The passive FSP*p* is shadowed, from the right side, by the active FSP*a* from the flows of fations 2 directed within the limits of the solid angle element $d\Omega$ of the solid angle $\Omega$ (unidirectional flows having energy density $\varepsilon_G^*$). Only the flows 3, reflected from FSP*a*, fall on the FSP*p* under a plane angle $\Omega_p$, from the right side. Analogous flows 4 acts from the left side. The difference of the force elements $dF_{left}$ and $dF_{right}$ created by these flows pushes FSPp to FSPa. Part of fations coming from the left side is shadowed by FSPp and not falls on the FSPa (see main text).

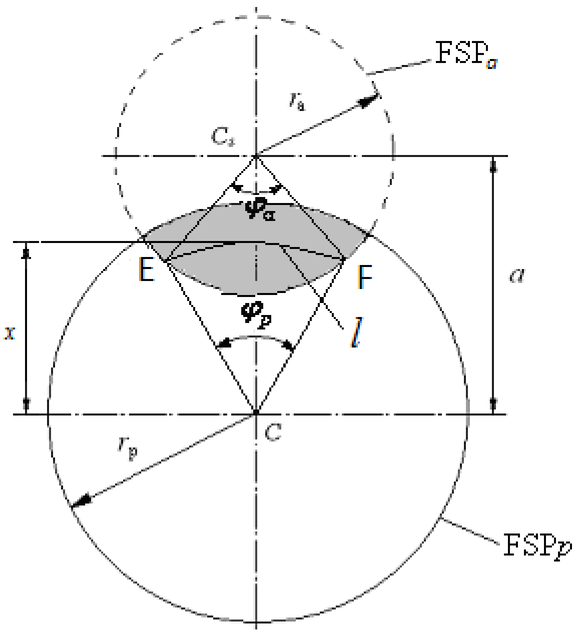


**Figure 2(b).** Cross-section on BCD (figure 2a). The force element is proportional, in modulo, to the area of the shadow element, $ldxd\Omega$, that falls on the cross-section BC of the passive FSP*p* from the active FSP*a* (Figure 2a); $C_s$ is the shadow center; $r_a$ and $r_p$ are radii of active and passive FSPs.

Next, it is convenient to go over to nondimensional variables, using relations: $\sin\left(\Omega_p+\alpha\right)=\dfrac{x}{r_p}=x^*$, $a/r_p=a^*$, $\rho/r_p=\rho^*$.

Finally, using above relations (25), (26), and (17), we obtain the total formula for the elastic part of collisions as

$$F_{Gff}^{elast}=\frac{\pi\ r_a^2\ r_p^2\ \varepsilon_G\left(1-\delta_p\right)\delta_a}{4R^2}k\left(R^*,\delta_a\right)\left(\int_{1-\gamma_a}^{1+\gamma_a}\frac{4a_1^*\gamma_p^2}{\pi\cos\Omega_{p1}}da_1^*\int_{a_1^*-\gamma_a}^{1}d\sigma_1^*+\int_0^{1-\gamma_a}\frac{4a_2^*\gamma_p^2}{\pi\cos\Omega_{p2}}da_2^*\int_{a_2^*-\gamma_a}^{a_2^*+\gamma_a}d\sigma_2^*\right),\quad(27)$$

where $\gamma_a=r_a/r_p$, $r_p=1/r_a$, $k\left(R^*,\delta_a\right)=\left[1+\mathrm{k}\left(\mathrm{R}^*\right)\left(1/\delta_a-1\right)\right]$;

$$d\sigma_1^*=\varphi_{p1}\rho_1^*\left(1-x_1^{*2}\right)dx_1^*;\quad(28)$$

$$d\sigma_2^*=\varphi_{p2}\rho_2^*\left(1-x_2^{*2}\right)dx_2^*;\quad(29)$$

$k\left(R^*\right)$ is given by (7).

Proceeding from trivial relations

$$r_p\sin(\varphi_p/2)=r_a\sin(\varphi_a/2)\ ;\ \ a=r_a\cos\left(\varphi_a/2\right)+\rho\cos\left(\varphi_p/2\right),\quad(30)$$

we obtain, for $\gamma_a=r_a/r_p\le 0.5$,

$$\varphi_{p1}=\arccos\frac{a^2+\rho^2-r_a^2}{2a\rho}\quad(31)$$

and, for $\gamma_a=r_a/r_p>0.5$,

$$\varphi_{p2}=\arccos\frac{r_a^2-a^2-\rho^2}{2a\rho}.\quad(32)$$

In the last case, if $x_1^*<0$, then $\varphi_p=0$, in order to avoid of a double summation, and also if $\rho_1^*<\gamma-a_1^*$, then $\varphi_p=2\pi$, and arcs become rings. Having denote expression in the brackets (27) by $I_{elast}$ and using expressions (28), (29), (31), (32) we obtain

$$I_{elast}=\left(\int_{1-\gamma_a}^{1+\gamma_a}\frac{4a_1^*\gamma_p^2}{\pi\cos\Omega_{p1}}da_1^*\int_{a_1^*-\gamma_a}^{1}d\sigma_1^*+\int_0^{1-\gamma_a}\frac{4a_2^*\gamma_p^2}{\pi\cos\Omega_{p2}}da_2^*\int_{a_2^*-\gamma_a}^{a_2^*+\gamma_a}d\sigma_2^*\right)=1\quad(33)$$

for any relative distance $R^*=R/r_p$ >10 and independently from the ratio $\gamma_a=r_a/r_p$.

We solved (33) by numerical method using Simpson's formula.

Then, taking into account (21), (22), (27), (33), we describe the total formula for the shadow gravity as

$$F_{Gff}^{total}=F_{Gff}^{inelast}+F_{Gff}^{elast}=\frac{\pi\ \varepsilon_G\delta_a r_p^2\ r_a^2}{4R^2}k_{total},\quad(34)$$

where

$$k_{total}=k\left(R^*,\delta_a\right)\left[I_{elast}+\delta_p\left(1-I_{elast}\right)\right].\quad(35),$$

Taking into account that, $I_{elast}$ =1 also, we find that the expression in the square brackets of (35), equals 1 and, therefore, we find finally exact formula for shadow gravitation for any distances $R^*=R/r_f>10$ as

$$F_{Gff}=\frac{\pi\ \varepsilon_G\delta_a r_p^2\ r_a^2}{4R^2}k\left(R^*,\delta_a\right),\quad(36)$$

where $k\left(R^*,\delta_a\right)$ is given by (9). Since the distance $R=10r_p$ is very small we will find below (52) that radius of FSP $r_f<10^{-55}$ m. Here and further $r_f=r_p$; subscript $f$ implies "fundamental".

## 3. Approximate numerical analysis of some parameters of matter and discussion of the Shadow gravity difficultness

*The basic objection against the Fatio-Lesage idea* is huge increasing of temperature as a result of the absorption of the fation energy [6]. By Poincaré's estimation the increase of Earth temperature must be $10^{26}$ degrees per second. This problem is solved on base of a model of the exploding electron [2] and [3]. The electron, in accordance with this model, absorbs fations gas energy and being exploded emits it in the form of *the charged electric field sub-particles* (EFS), whereas the generally excepted electrostatic field considered as flows of neutral photons. I assume that electrons generate negative EFS, and positrons (and protons) generate positive EFS. The idea of the exploding electron and the new notions about electric field was already considered in [2] and [3, 7] in detail; therefore here we will touch upon them only briefly and in simplified way.

The electron absorbs the fation gas energy during the time $T$ and explodes. The electron explosion has two stages. The explosion corona, in the course of the first stage, is expanded similarly to a compressed matter. Hereafter the first stage of the explosion will be referred to (for short) as the E-corona. At the instant when the radius of the E-corona is increased to value $R_m$, it disintegrates into separate sub-particles. This is the beginning of the second stage. One after another, flows of these new sub-particles produce spherical $\lambda$ layers radiated with velocity of light $c$ (like the classical electric field). The thickness of each moving $\lambda$ layer is constant and is given by [2, 3]

$$\lambda = cT\ , \tag{37}$$

where $c$ is the light speed. As has been mentioned above, the electron has a very small core, which remains in stable state by pressure of the fation gas. Therefore practically all the E-corona energy is the electron self-energy.

The electron-positron annihilation can be an evidence of this assertion, inasmuch as the energy of the created, in doing so, gamma quanta is equal to $2m_ec^2$, whereas mass of the gamma quant assumed being massless (According to experiments the photon mass $<10^{-52}$ kg [8]). It follows from this also that the core mass is extremely small, and all absorbed by the electron fation energy is equal to the electron self-energy according to the following equation

$$\sigma_{eG}\varepsilon_G\delta_a\lambda C_G^* = m_e c^2\ , \tag{38}$$

where $\sigma_{eG}$ is gravitation cross-section of the electron, $m_e$ is its mass, $C_G^*=c_G/c$ is the ratio of the unknown gravitation speed to of the light speed. We use $C_G^*=1$ in all calculations although an experimental evidence for this as yet absents.

According to (36) the shadow gravitation force acting between two electrons, in comparison with Newton's law, in macroscopic cases, when $k\left(R^*,\delta_a\right)=1$, is equal to

$$F_{Gee}^{\infty} = \frac{\varepsilon_G\delta_a\sigma_{eG}^2}{4\pi R^2} = \frac{m_e^2 G}{R^2}\ , \tag{39}$$

where $G$ is gravitational constant. In (39) we consider, in the first approximation, the gravitation cross-section $\sigma_{eG}$ and mass $m_e$ of the active electron be equal to respective parameters of the passive one.

From (38) and (39), we can calculate the value of the energy density of the fations gas, which being absorbed by bodies and, thus, takes part in creating gravitational force, as

$$\varepsilon_G\delta_a = \frac{c^4}{4\pi G\,\lambda^2 C_G^{*2}} = 6.4586\times10^{67}\ \text{Jm}^{-3} \tag{40}$$

and the value of the gravitation cross-section of the electron as

$$\sigma_{eG} = \frac{4\pi m_e G\lambda C_G^*}{c^2} = \frac{2GhC_G^*}{c^3} = 3.2827\times10^{-69}\ \text{m}^2, \quad (41)$$

where $\lambda = \lambda_C = h/(m_e c) = 3.6851\times10^{-13}$ m [7], $h$ is Planck's constant. Thus, $\sigma_{eG}$ is comparable to Planck's area ($Gh/c^3 = 2.6122\times10^{-70}$ m$^2$).

The quantity $\sigma_{eG}$ is the sum of cross-sections of all FSPs, which are constituents of the electron. The structure of the exploding electron is described in more detail in [3].

The mean geometrical cross-section of the E-corona equals

$$\bar{\sigma}_{egeom} = (\pi/\lambda)\int_0^\lambda r_t^2 dr_t = \pi\lambda^2/3 = 1.4\times10^{-25}\,\text{m}^2, \quad (42)$$

where $r_t$ is variable radius of the exploding E-corona. Here we consider the core radius as $r_c << \lambda$. Below we estimate $r_c < 10^{-46}$ m, whereas $\lambda = 3.6851\times10^{-13}$ m.

Thus, the electron absorbs only $\sigma_{eG}\,\delta_a/\sigma_{egeom} \sim 10^{-84}$ part of the fation gas energy, where $\delta_a = 1.2803\times10^{-42}$, see below (46). It is practically transparent for the fations gas. Therefore fations, practically freely, reach the E-core and bombard it from all sides.

Next (analogously [3]), based on the model of the exploding electron we can interpret *the electron charge as ability to absorb fations and generate energy of EFS*. This energy is proportional to the gravitational cross-section of the electron, $\sigma_{eG}$, hence the electron charge $e$ is also proportional to $\sigma_{eG}$. Respectively the FSP charge, $q_f$, is proportional to $\pi r_f^2$.

Let the FSP charge be uniformly distributed on its surface, then the repulsive force from the FSP charge $q_f$ acts on any element $\Delta S$ of the FSP surface in accordance with Coulomb's law. This force is equilibrated by the force that is proportional to energy density of the fations gas $\varepsilon_G$ in accordance with the equation

$$\frac{q_{\Delta S}\,q_f}{4\pi\varepsilon_0 r_f^2} = (1/3)\varepsilon_G\Delta S, \quad (43)$$

where $\varepsilon_0$ is the electric constant, $(1/3)\varepsilon_G$ is the pressure of the fation gas onto FSP [5]. Then, from simple proportionality we find the charge of the element, $\Delta S$, as

$$q_{\Delta S} = \frac{q_f\Delta S}{4\pi r_f^2}. \quad (44)$$

Analogously from the proportionality of the electron charge, $e$, to its gravitation cross-section, $\sigma_{eG}$, and the proportionality of the FSP charge, $q_f$, to its gravitation cross-section, $\pi r_f^2$, we obtain

$$q_f = \frac{\pi r_f^2 e}{\sigma_{eG}}. \quad (45)$$

We have considered ratios of cross-sections as equivalents to ratios of sphere surfaces.

Solving (41), (43-45) together, we obtain

$$\delta_a = \frac{64\pi m_e^2 G\varepsilon_0}{3e^2} = 1.2803\times10^{-42}. \quad (46)$$

As is seen from (46), only an extremely small part of the fations takes part in inelastic collisions. Then, after substituting $\delta_a$ from (46) in (40) we obtain the value of the fation gas energy as

$$\varepsilon_G = \frac{3}{\varepsilon_0}\left(\frac{c^2 e}{16\pi m_e G\lambda C_G^*}\right)^2 = 5.0445\times10^{109}\ \text{Jm}^{-3}. \quad (47)$$

Obtained value of the energy density of the fation gas is huge, therefore in order to provide its penetrating capability the fations sizes must be very small. In addition, the value of $\varepsilon_G$ may be lesser if $C_G^*$ will be found >>1. We as yet cannot estimate numerical value of the fation size.

Next, if Einstein's formula $E = mc^2$ is valid for sub-electronic level, then we can use the following equation

$$\left(4/3\right)\pi r_f^3 \varepsilon_f = m_f c^2 , \tag{48}$$

where $\varepsilon_f$ is the energy density of the FSP matter, which, obviously, larger than $\varepsilon_G$, therefore we evaluate the radius of FSP as

$$r_f < \left(\frac{3m_f c^2}{4\pi\varepsilon_G}\right)^{1/3} . \tag{49}$$

Analogously to (39) from the comparing the shadow force between two FSP with Newton's formula and after substituting $\varepsilon_G \delta_a$ from (40) we find the value of the FSP radius as

$$r_f = \left(\frac{4m_f^2 G}{\pi\varepsilon_G\, \delta_a}\right)^{1/4} = \frac{2\sqrt{m_f G\lambda C^*}}{c} . \tag{50}$$

After comparing this relation with (49) and substituting (47) we obtain

$$m_f < \frac{64\pi^2 m_e^4 c^2 G\lambda \varepsilon_0^2 C_G^*}{e^4} = 1.1986\times 10^{-70} \text{ kg.} \tag{51}$$

Finally, substituting $m_f$ into (50) gives

$$r_f < \frac{16\pi m_e^2 G\lambda\varepsilon_0 C_G^*}{e^2} = 3.7080\times 10^{-55} \text{ m.} \tag{52}$$

Now, we can evaluate the number of FSPs in the electron as

$$N_{fe} \cong \frac{m_e}{m_f} > 7.6000\times 10^{39} . \tag{53}$$

We do not took into account here that the E-corona can include also another sub-particles [3].

Using an equation analogously to (39) we can calculate the E-core radius as

$$r_c = \left(\frac{4m_c^2 G}{\pi\varepsilon_G\, \delta_a}\right)^{1/4} < 2.4\times 10^{-46} \text{ m,} \tag{54}$$

where we set the core mass $m_c < 5.03\times 10^{-53}$ kg proceeding from the fact that the mass of the photon, which is created by electron-positron annihilation, and having 2 cores is $m_\gamma < 1.07\times 10^{-52}$ kg [8] .

Next *objection against the Fatio-Lesage idea is* a requirement of the extreme porosity of bodies; which must consist mostly of empty space so that the fations can penetrate Indeed, matter is very porous; neutrinos freely go through the Earth and neutron stars. Above we have shown that area of gravitation cross-section (41) of the electron on 44 orders less its geometrical cross-section area.

The nucleons, from which consists almost all matter, has gravitation cross-section (GCr-S) as

$$\sigma_{nG} = \frac{4\pi m_n G\lambda c_G^*}{c^2} \sim 10^{-65}\,\text{m}^2, \tag{55}$$

And its geometrical cross-section is equal to

$$\sigma_{ngeom} = \pi r_n^2 = 10^{-30} \quad \text{m}^2. \tag{56}$$

For all bodies and cosmic objects, since they basically consist of protons and neutrons, the formulae have forms analogous to (55), differing only by value of masses. From this for neutron stars, having mass ~$10^{30}$ kg and radius ~ $10^4$ m, a shielding probability is equals about $10^{-52}$.

Analogously, for the Earth ($M_{Earth} = 6\times10^{24}$ kg):

$$\sigma_{GEarth} = \frac{M_{Earth}\sigma_n}{m_n} \sim 10^{-14} \text{ m}^2, \tag{57}$$

and the geometrical cross-section of the Earth equals

$$\sigma_{Earthgeom} = \pi R^2_{Earth} \sim 10^{14} \text{ m}^2, \tag{58}$$

where $R_{Earth} = 6.4\times10^6$ m. Thus the Earth absorbs less than $\overline{\sigma}_{GEarth}\delta_a / \sigma_{Egeom} =\sim 10^{-69}$ part of the fations gas energy.

It is interesting to note that if to concentrate all FSPs of the Earth in single spherical volume, then a radius of this volume will be equal to ~$10^{-23}$ m!

Finally, for the seen part of the Universe GCr-S is

$$\overline{\sigma}^*_{GUniverse} = \frac{M_{Universe}\sigma_n}{m_n} \sim 10^{16} \text{ m}^2, \tag{59}$$

where $M_{Universe} = 3.5\times10^{54}$ kg (without regard for the hypothetical dark matter).

Geometrical cross-section of the seen Universe, for its radius $R_{Universe} = 4.4\times10^{26}$ m, is equal to

$$\sigma_{Universegeom} = 6.1\times10^{53} \text{ m}^2. \tag{60}$$

Thus, at most $\sigma_{GUniverse}\delta_a / \sigma_{Universegeom}$ ~$10^{-79}$ part of the fations gas is absorbed as a result of its passage through the Universe. From this it follows that, even if fation gas absorbed by all matter and converted into EFS, finally is converted into *another form of matter thinner than that of fations* (in consequence of annihilating of $EFS^+$ with $EFS^-$), its energy density is decreased on the insignificant part after time of the big band. This makes groundless the objections about attenuation of the fations gas density as result of its absorption by matter [9, 10]. It also follows from this that known assumptions about *decreasing gravitational constant with time have no sense*.

In all above calculations it was neglected by a hardly probable shielding each other of fundamental sub-particles in connection with their extreme rarefaction and small value of GCr-S. Indeed, it is not difficult to show that for example, for a neutron star, having mass ~$10^{30}$ kg and radius ~ $10^4$ m, a shielding probability is equals about $10^{-52}$. Therefore, respective criticism of shadow-gravity on this question [9, 10] becomes groundless.

One adduce in literature so called mass proportionality, which is that the shadow gravity force is proportional to product of gravitation cross-sections of bodies whereas Newtonian force is proportional to masses of bodies.

Analogously to (39) we can write equation of interaction two equal bodies as

$$F^{\infty}_{G} = \frac{N_f^2\ \varepsilon_G\delta_a\sigma_f^2}{4\pi R^2} = \frac{N_f^2\ m_f^2 G}{R^2}. \tag{61}$$

If to reduce it by the factors $N^2$ (numbers of FSPs in bodies) and $R^2$, then all remaining parameters will be constants in this equation. Inasmuch as $\varepsilon_G$ and $G$ are dimensional quantities, then there is no problem. Furthermore, from (61) we can clear up the nature of the gravitation constant, $G$. If to substitute $m_f$ from (51) in (61), we obtain the expression for the gravitation constant as

$$G = \frac{9\varepsilon_G\delta_a c^4}{64\pi\varepsilon_f^2 r_f^2}. \tag{62}$$

Finally, the most complicated difficultness is *the resistance of the fation gas for moving bodies*. I have named this as "contrary wind" [2]. Fatio had found that the resistance is proportional to $\rho uv$ but gravity (i.e. the particle pressure) is proportional to $\rho v^2$. From this it follows the more speed $v$ of fations the less the contrary wind. Laplace, calculated a gravity propagation speed no less than $10^7 c$. Unfortunately, we do not have direct measurements of the gravity propagation speed. If such measurements will be performed and the gravity speed will be found equal to $c$, then we will be forced to find another way to solve the problem of the contrary wind. For example, one may to assume that

FSPs are impenetrable for fations until their incident speed not larger than $c$, otherwise fations pierce through FSPs without transmitting it a momentum [11]. In any case this difficulty has a solution and cannot be a cause for rejecting the shadow gravity idea. Furthermore, there is experiments [12], which, with taking into account their interpretation [13, 14], confirms the shadow-gravity.

All above results of numerical calculations slightly differ from [3] because here we, on the one hand, have used more exact formula (36) for the shadow gravity force (it twice less than that in [3]) and, on the other hand, (for simplicity) we have not taken into account some features of the electron structure, which we have considered in detail in [3].

## 4. Strong gravitation

Since, accordance with (46), $1/\delta_a >> 1$, we may omit 1 in (9) and, taking into account also (7), finally to write

$$k\left(R^*,\delta_a\right) = 1 + \left[1 - \sqrt{1-\left(r_f / R\right)^2}\right] / \delta_a . \qquad (63)$$

Now, using obtained values of the parameters we calculate the numerical values of gravity multiplayer $k\left(R^*,\delta_a\right)$ as function of $R^*$ and $R$. Results are represented in the table and in form of the diagram in Fig. 3. We give also $k_{total}$ in order to show that they are equal to each other, except for very short distances $R < 3.7081\times10^{-53}$ m.

As is seen from the table and Fig. 3, when $R^* \to \infty$ coefficients $k_{total}$ and $k\left(R^*,\delta_a\right) \to 1$. Practically when $R^* = 10^{-23}$ ($R = 3.7080\times10^{-32}$ m) we can consider these coefficients be equal to 1, but at short distances (beginning from Planck's length) they has very large values, and thus *gravitation becomes strong*. On the shortest distance $7.4161\times10^{-55}$ m it is *comparable to electromagnetic interaction*. Thus, the known *enigmatic number, $10^{42}$, has a simple explanation*.

It should be pointed out also that neither Newton's nor Einstein's theories do not predict the strong gravitation at short distances.

Table. Results of calculations by (33, 35) and (63) for $r_f = 3.7080\times10^{-55}$ m and $\delta_a = \delta_p = 1.2803\times10^{-42}$

| $R$, m | $R^* = R / r_f$ | $k\left(R^*,\delta_a\right)$, f. (63) | $k_{total}$, f. (35) | $I_{elast}$, f. (33) |
|---|---|---|---|---|
| $7.4161\times10^{-55}$ | 2 | $1.0467\times10^{41}$ | $1.2071\times10^{41}$ | 1.1533 |
| $3.7080\times10^{-54}$ | 10 | $3.9161\times10^{39}$ | $3.9324\times10^{39}$ | 1.0042 |
| $3.7081\times10^{-53}$ | 100 | $3.9063\times10^{37}$ | $3.9064\times10^{37}$ | 1.0000 |
| $3.7081\times10^{-52}$ | 1000 | $3.9063\times10^{35}$ | $3.9061\times10^{35}$ | 1.0000 |
| $3.7081\times10^{-51}$ | 10000 | $3.9063\times10^{33}$ | $3.9061\times10^{33}$ | 1.0000 |
| … | … | … | … | … |
| $3.7081\times10^{-38}$ | $1\times10^{17}$ | $3.9063\times10^{7}$ | $3.9053\times10^{7}$ | 1.0000 |
| $3.7081\times10^{-37}$ | $1\times10^{18}$ | $3.9063\times10^{5}$ | $3.9061\times10^{5}$ | 1.0000 |
| $3.7081\times10^{-36}$ | $1\times10^{19}$ | 3907.25 | 3907.133 | 1.0000 |
| $3.7081\times10^{-35}$ | $1\times10^{20}$ | 40.0625 | 40.0613 | 1.0000 |
| $3.7081\times10^{-34}$ | $1\times10^{21}$ | 1.3906 | 1.3906 | 1.0000 |
| $3.7081\times10^{-33}$ | $1\times10^{22}$ | 1.0039 | 1.0039 | 1.0000 |
| $3.7081\times10^{-32}$ | $1\times10^{23}$ | 1.0000 | 1.0000 | 1.0000 |

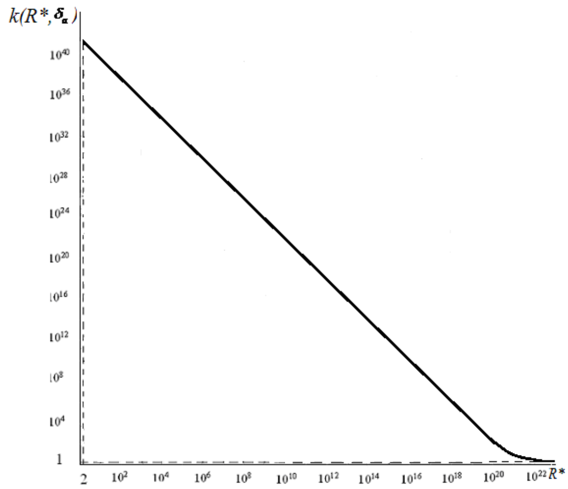


**Figure 3.** Diagram of dependence of the factor $k\left(R^*,\delta_a\right)$ from the ratio $R^* = R/r_f$ for $\delta_a = 1.2803\times10^{-42}$

## 8. Conclusion

An improved self-consistent model of the Shadow-Gravity has been developed and the exact formula for the shadow gravity force is derived. The obtained numerical results showed that known objections against shadow-gravity model become groundless. The obtained new formula for shadow-gravity force for any, including *short, distances* can be important for the particle physics theory.

We show that the reduction of the fations gas energy density in result of absorbing it by substance is equal to less than ~$10^{-79}$ part of the all fation gas of seen Universe during the time from the big bang. Therefore supposed change of the gravitational constant with time is unobservable small.

The problem of the "contrary wind" considered, but it still remains without a final solution.

The new improved factor $k\left(R^*,\delta_a\right)$ for the strong gravity force is derived. Gravity force becomes strong beginning from distance $\sim10^{-35}$ m (Planck's length) and reaches $1.0464\times10^{41}F_{Gff}^{\infty}$ at distance $<7.4161\times10^{-55}$ m between FSPs, where $F_{Gff}^{\infty}$ is the gravitation force for macroscopic conditions: practically at $R>3.7081\times10^{-32}$ m, when the factor $k\left(R^*,\delta_a\right)$ becomes equal to 1.0000. Thus, at the distance $R<7.4161\times10^{-55}$ m gravitation force becomes comparable to the electrostatic force, and, thus, the known enigmatic relation $10^{42}$ gets a simple explanation.

Given in literature notion about a strong gravitation "constant", evidently, is not valid inasmuch as the factor $k\left(R^*,\delta_a\right)$ is function of distance *R*. The production $Gk\left(R^*,\delta_a\right)\sim10^{30}$ $m^3$ $kg^{-1}$ $c^{-2}$ is comparable to given in [15 – 17] numerical values $\sim10^{28}...10^{31}$ $m^3$ $kg^{-1}$ $c^{-2}$ only at minimal possible distance between FSPs , $R/r_f$=2, where $r_f$ is the fundamental sub-particle radius.

Finally, I would like to notice that we have not made any arbitrary assumption throughout the paper, except existence of the fation gas filling outer space (by Fatio-Lesage's hypothesis) and electron explosions, but these assumptions are justified out by the self-consistent unified model of shadow gravity and the exploding electron based on these conjectures.

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