Exact Formula for Shadow-Gravity, Strong Gravity

Nikolay V. Dibrov

Prospect Gagarina, No 175, ap. 43, Kharkov, Ukraine
Email: nikdibrov@gmail.com

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Abstract

A new more exact formula, than that recently published (Apeiron, Vol. 18, No 2 (2011)), for Shadow-Gravity force, for any distances between fundamental sub-particles, including very short ones when gravitation becomes strong, is developed. It is found also that, in fundamental contrast to Darwin's conclusion, the gravitation effect is performed *at the expense of elastic collisions of fations with* fundamental sub-particles, and thus the well known basic objection against the shadow-gravity (the thermal problem) becomes baseless.

Keywords

Shadow-Gravity, Strong Gravity, Exploding Electron, Hypothetical Sub-Particles

Subject Areas: **Computational Physics, Modern Physics**

1. Introduction

The hypothesis of the shadow-gravity was originally proposed by Nicolas Fatio Duillier in 1690. Later (1748) Georges-Louis Le Sage somewhat developed this idea. Fatio reported on his idea to the Royal Society in London, but did not publish it in his lifetime. Therefore this hypothesis is far-famed as Lesage's theory [1] [2].

Fatio have assumed that the Space is filled with microscopic unseen particles, moving in all directions with large velocities, and weakly absorbed by bodies. Lesage had named them as ultra-mundane corpuscles. These corpuscles have been called *lesagons* in the work [3], in which an attempt to develop Fatio-Lesage's idea was also made, but I named them as *fations* in honor of Fatio who first proposed this idea.

Fations, bombarding bodies from all sides, exert a pressure on bodies. As a consequence, both the density of the fations in areas between bodies and the pressure on bodies are reduced, resulting in attractive forces on the bodies. To be more exact, bodies *are pushed* towards each other.

The idea of the shadow-gravity gives us the simple and visual mechanism of gravitation, but there are some difficulties. Most serious objections adduce Maxwell and Poincaré [4]. Originally Fatio came to conclusion that gravitational effect can exist only if fations bombard bodies with non-elastic collisions. But in this case the body temperature, as a consequence of the energy absorption, must rapidly rise to a high level. In this paper I have found a radical solving this problem. A complete list of objections can be found, for example, in [5]. I have given answers on most of them in my previous papers [6] [7].

I was aware, for the first time the formula for the shadow gravity force was obtained by Darwin in 1905 [8]. He considers the conjectural case when the fations impact the bodies partially elastical with some coefficient k, which is 1 for a complete inelasticity, and 2 for perfect elasticity. *Darwin did not consider fations are reflected between the particles of interacting bodies*, whereas, as we will show in this paper, this feature plays the decisive role in the shadow-gravity. The final formula obtained by him (in result of cumbersome derivations) is approximately valid only for $k=1$, perfect smoothness and macroscopic distances between the interacting particles; it has the form

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

where (in original denotation) ρ is a mass density of the fation gas, v is the fation velocity, a and b are radii of spherical particles of interacting bodies, R is the distance between them.

In [6] I have found a more exact formula by a method, which differs from Darwin's one. I had used the notion about a gravitational *shadow area*. The formula 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 the electron core[1]; δ is the factor, which has the meaning of the probability of absorbing of fations by the core. The factor δ *is the ratio of the part of fations absorbed by the core to the all fations bombarding the core.* For reasons, that we have considered in detail in [6] [7], δ has named as the asymmetry factor. I introduced also notion of energy density ε_G of the fation gas instead of Darwin's $\rho v^2/2$, and considered impacts with perfect smoothness.

In [7] I have introduced the notion about *fundamental sub-particles* (FSP) from which all substance consists. I suggest considering as fundamental such sub-particles, which are *absolutely impermeable* 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. In [7] I have found the more exact (although not enough exact) formula as

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

where δ_a and δ_p are the asymmetry factors for active and passive FSPs, respectively, r_a and r_p are radii of respective FSPs, $k\left(L\right)$ is the factor, which for macroscopic conditions, when $L\gg r$, is equal to 1 and for short distances it becomes very large, and gravitation becomes strong. I have taken into account also *fations that reflected between the interacting FSPs.*

Unlike Darwin, in this paper, I consider that each fation is either absorbed or reflected randomly with some probability δ; therefore we can consider action of elastic and inelastic blows separately and then sum obtained results.

2. The Updated Formula for the Shadow-Gravity Force

2.1. The Component of the Force from the Action of Inelastic Collisions

Let us consider (as I have done it in [7]) the gravitational interaction between two FSPs (**Figure 1(a)**) regardless of a possible electric forces acting between them. For convenience, the FSP which "creates a gravitational field" (creates 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 [7] 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*

[1]According to my hypothesis of the exploding electron [6] [7] the last has a very small core, which remains in the stable state by pressure of the fation gas, whereas the electron corona, periodically explodes and is renewed by absorbing fations.

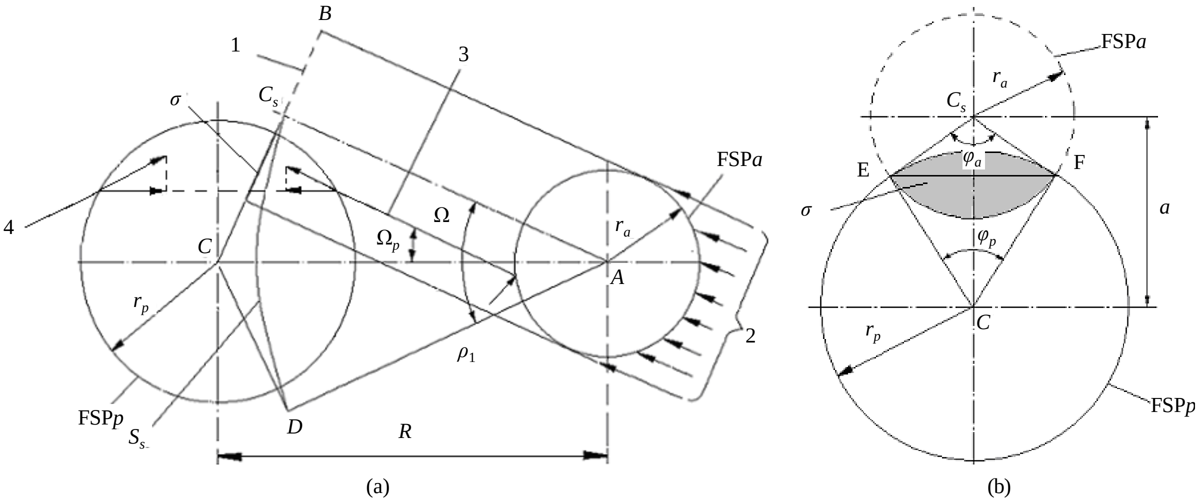

Figure 1. (a) Scheme for the calculation of the shadow force of gravity acting on the FSP.The passive FSPp is shadowed, from the right side, by the active FSPa from the flows of fations 2 directed within the limits of the solid angle element $d\Omega$ of the solid angle Ω (unidirectional flows having energy density ε_G^*). Only flows 3, reflected from FSPa, fall on the FSPp under a plane angle Ω_p, from the right side. Analogous flows, 4, act on FSPp from the left side; (b) Cross-section along BCD (on (a)). The force element is proportional, in modulo, to the area of the shadow element, σ, that falls on the cross-section BC of the passive FSPp from the active FSPa (a). C_s is the shadow center; r_a and r_p are radii of active and passive FSPs.

Cross-section (*GCr-S*). Gravitational effect is possible only if fations, at least partially, are absorbed by bodies (by FSPs in the final analysis). As Darwin noted [8], 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 $(\delta_a = 0)$. We will show in this paper that the gravitational effect is performed only at the expense of elastic collisions of fations with FSP.

As we noted above, we will consider that part of fations impacts, with some probability δ 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 summed.

In the same manner as in [7] let us consider two FSPs: passive p and active a (**Figure 1(a)**). The passive FSPp is shadowed, from the right, by the active FSPa from the flows of fations 2 directed within the limits of the solid angle element $d\Omega$ of the solid angle Ω (unidirectional flows having energy density ε_G^*). Therefore only flows 3, reflected from FSPa, come to the FSPp under the plane angle Ω_p from the right side. These flows have energy density $\varepsilon_G^*(1-\delta_a)$, because FSPa absorbed a part of fations proportionally to the factor δ_a, therefore these flows act on the FSPp, 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 subscripts p and a at δ in case where passive and active FSP have different value of asymmetry factors[2]. In the opposite direction (from the left side) flows 4 also act with the 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, come to FSPa and then, being reflected from FSPa, come to FSPp from the right side, inasmuch as the FSPp screens some part of them, therefore it is necessary to introduce a coefficient $\left[1-k\left(R^*\right)\right]$ for the fations that come to FSPp from the right side. We denote $R^* = R/r_p$, where R is the distance between FSPs, and r_p is the radius of FSPp. Thus, resultant element of the force, which acts on FSPp in direction to FSPa, is proportional to

[2]In principle, it is possible a case when $\delta_p = 0$. In this case gravitational force will act on the passive particle although the passive particle itself cannot "create gravitational field".

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

where coefficient $k\left(R^*\right)$ has a sense of the probability of screening of the fation flow by FSPp. This geometric probability can be found as

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

where Ω_f is the solid angle within limit of which fations freely come to FSPa and then, being reflected from FSPa, come to FSPp from the right side, and Ω_s is the solid angle screened by FSPp. The vertex of all these angles is in the center *A* of active FSPa (**Figure 1(a)**). Figuratively speaking, Ω_s is the solid angle under which FSPp is seen from the centre *A*. It is equal to [7]

$$\Omega_s=\frac{S_{rp}}{\rho_1^2}=2\pi\left(1-\sqrt{1-\left(\frac{r_p}{R}\right)^2}\right), \tag{6}$$

where S_{rp} is the area of the spherical surface having radius ρ_1.

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 put $\Omega_f+\Omega_s\approx 2\pi$ regardless of 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, therefore we do not give exact calculations here because they, in addition, are extremely cumbersome.

As was noted above, gravitational effect is proportional to the shadow, which comes to the passive FSPp from the active FSPa with taking into account above features connected with fations reflected from the FSPa. Actions of all other fations, that bombard the FSPp from right and left sides, counterbalance each other.

Thus, the cross-section element σ (in **Figure 1(b)** it is shaded), is shadowed from the fations directed within the limits of the element $\mathrm{d}\Omega$ of the solid angle Ω. Total area of the shadow is equal to sum of the elements σ, when the center C_s of the shadow (**Figure 1(a)**) circumscribes the circle with radius $a\cos\Omega_p$ and the plane angle Ω_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 Ω goes through the values from 0 to $\Omega_{\max}$. Thus, the force acting on the total shadow area in the direction to FSPa can be obtain, considering (4), as

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

where we denoted

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

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

Next from **Figure 1(b)** we find

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

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

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

Whence, taking into account (10), we obtain [7]

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

where and further $\gamma_a = r_a/r_p$, r_p and r_a are radii of the FSPp and FSPa 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 Ω 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 equal to

$$S_s = 2\pi\rho_1 h, \tag{13}$$

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

$$h = \rho_1\left(1-\cos\Omega_p\right) = \rho_1\left(1-\sqrt{1-(a/R)^2}\right), \tag{14}$$

where

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

Then substituting (14) in (13) we obtain the expression for the solid angle as

$$\Omega = \frac{S_s}{\rho_1^2} = 2\pi\left\{1-\left[1-\left(\frac{a}{R}\right)^2\right]^{1/2}\right\}. \tag{16}$$

Differentiating this relationship with respect to a, we obtain [7]

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

From simple trigonometric relations (**Figure 1(b)**), taking into account also (10), we obtain [7]

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

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

By differentiating (18) with respect to φ_a, we obtain [7]

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

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

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

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

$$I_{\mathrm{inelast}} = \frac{a' f_1(\varphi_a)\left(-f_2(\varphi_a)\right)}{2\pi}\mathrm{d}\varphi_a + \frac{2}{r_p^2}\int_0^{r_p - r_a} a\mathrm{d}a. \tag{21}$$

We have used expressions for two limits of integrating (21). First of them is equal to 2π, 0, for the variable φ_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 $\sigma = \pi r_a^2$ have used instead of (12). The first integral is for the situation when FSPp is partially shadowed (like the waning moon) as depicted in **Figure 1(b)**, and second for cases when the shadow from FSPa is wholly situated within the cross-section of FSPp.

New Formula (20) 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 this is the case only, if $\delta_a = 0$, *i.e.* if *all* fations bombard bodies elastically.

2.2. The Component of the Force from the Action of Elastic Collisions

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

In this case we must resolve the momentum vector on radial and tangential components, but take into account only the radial component, because the tangential component is removed by the reflected fations (**Figure 2(a)**). We assume that the collisions are perfectly smooth.

Thus, the horizontal projection of the force element $\mathrm{d}F_{\text{left}}$ acting on the surface element of FSPp $\mathrm{d}s$ from the left side is equal to

$$\mathrm{d}F_{\text{left}} = 2\varepsilon_G^*(1-\delta_p)\cos^2(\Omega_p+\alpha)\cos\alpha\,\mathrm{d}\Omega\mathrm{d}s\,. \tag{22}$$

The analogous element acts from the right side

$$\mathrm{d}F_{\text{right}} = 2\varepsilon_G^*(1-\delta_p)(1-\delta_a)\left[1-k(R^*)\right]\cos^2(\Omega_p+\alpha)\cos\alpha\,\mathrm{d}\Omega\mathrm{d}s\,, \tag{23}$$

where, in (22) and (23), we have taken into account only elastic collisions.

The resultant force element is

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

where we have taken into account that $\mathrm{d}s = \rho\varphi_p\mathrm{d}x/\cos(\Omega_p+\alpha)$, where $\rho\varphi_p\mathrm{d}x$ is an arcwise shadow element (**Figure 2(b)**) and $\rho = CF = abs(x)$, $\mathrm{d}\Omega$ is given by (16).

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

$$F_{\text{Gff}}^{\text{elast}} = \int_{\Omega_1}^{\Omega_{\max}}\int_{a-r_a}^{r_p}\mathrm{d}F_1 + \int_0^{\Omega_1}\int_{a-r_a}^{a+r_a}\mathrm{d}F_2\,, \tag{25}$$

where Ω_1 corresponds to the coordinate $a_1 = r_p - r_a$, and $\Omega_{\max}$ to the coordinate $a_{\max} = r_a + r_p$ (**Figure 2(b)**); the first double integral and the element of force $\mathrm{d}F_1$ correspond to situation when FSPp is partially shadowed as depicted in **Figure 2(b)**, and the second double integral and $\mathrm{d}F_2$ are for cases when the shadow from FSPa is wholly situated within the cross-section of FSPp.

Next, using relations (17) (24), and (25), let us take outside of integrals the constant parameters and go over to non-dimensional quantities, using relations: $\sin(\Omega_p+\alpha) = \dfrac{x}{r_p} = x^*$; $a/r_p = a^*$; $\rho/r_p = \rho^*$; $\cos\alpha = x^*\sin\Omega_p + \cos\Omega_p\sqrt{1-x^{*2}}$, $\gamma_a = r_a/r_p$. In result we obtain the total formula for the elastic part of collisions as

$$F_{\text{Gff}}^{\text{elast}} = \frac{\pi r_a^2 r_p^2\varepsilon_G(1-\delta_p)\delta_a}{4R^2}k(R^*,\delta_a)I_{\text{elast}}\,, \tag{26}$$

where

$$I_{\text{elast}} = \int_{1-\gamma_a}^{1+\gamma_a}\frac{4a_1^*}{\pi\gamma_a^2}\mathrm{d}a_1^*\int_{a_1^*-\gamma_a}^{1}\mathrm{d}\sigma_1^* + \int_0^{1-\gamma_a}\frac{4a_2^*}{\pi\gamma_a^2}\mathrm{d}a_2^*\int_{a_2^*-\gamma_a}^{a_2^*+\gamma_a}\mathrm{d}\sigma_2^*\,, \tag{27}$$

where

$$\mathrm{d}\sigma_1^* = \varphi_{p1}\rho_1^*\left(x_1^*\sqrt{1-x_1^{*2}}\,\mathrm{tg}\Omega_{p1} + 1 - x_1^{*2}\right)\mathrm{d}x_1^*\,; \tag{28}$$

$$\mathrm{d}\sigma_2^* = \varphi_{p2}\rho_2^*\left(x_2^*\sqrt{1-x_2^{*2}}\,\mathrm{tg}\Omega_{p2} + 1 - x_2^{*2}\right)\mathrm{d}x_2^*\,, \tag{29}$$

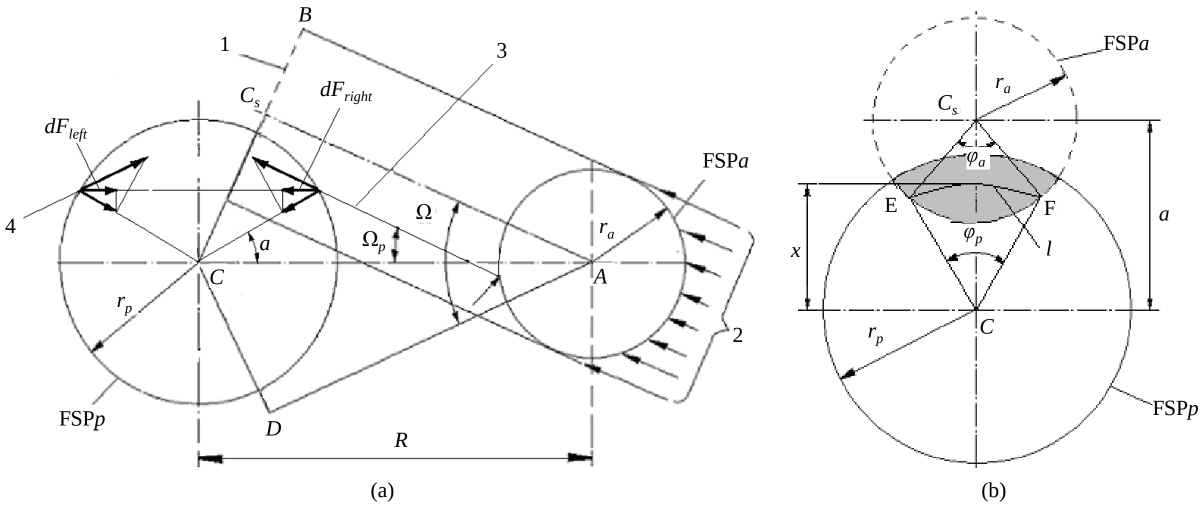

Figure 2. (a) Scheme for calculation of the shadow-gravity force acting on the FSPp from the action of elastic collision. The passive FSPp is shadowed, from the right side, by the active FSPa from the flows of fations 2 directed within the limits of the solid angle element $\mathrm{d}\Omega$ of the solid angle Ω (unidirectional flows having energy density ε_G^*). Only the flows 3, reflected from FSPa, fall on the FSPp under a plane angle Ω_p from the right side. Analogous flows 4 act from the left side. The difference of the force elements $\mathrm{d}F_{\text{left}}$ and $\mathrm{d}F_{\text{right}}$ created by these flows pushes FSPp to FSPa. (b) Cross-section on BCD (a). The force element is proportional, in modulo, to the area of the shadow element, $l\mathrm{d}x$, that falls on the cross-section BC of the passive FSPp from the active FSPa (a); C_s is the shadow center; r_a and r_p are radii of active and passive FSPs.

where $k\left(R^*,\delta_a\right)$ is given by (9).

Proceeding from trivial relations

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

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

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

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

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

In so doing if $x_1^*<0$, then $\varphi_p=0$, in order to avoid of a double summation, and also if $\rho_1^*<\gamma-a_1^*$, we put $\varphi_p=2\pi$, and arcs become rings.

The total force equal to the sum of elastic (26) and inelastic (20) components as

$$F_{\text{Gff}}^{\text{total}}=F_{\text{Gff}}^{\text{elast}}+F_{\text{Gff}}^{\text{inelast}}=\frac{\pi\varepsilon_G\delta_a r_p^2 r_a^2}{4R^2}k\left(R^*,\delta_a\right)\left(I_{\text{elast}}-\delta_p I_{\text{elast}}+\delta_p I_{\text{inelast}}\right), \tag{33}$$

where, since $\delta_p\sim 10^{-41}\ll 1$ [7], the expression in the brackets equals I_{elast}, and therefore the total force is performed *only at the expense of elastic collisions of fations with FSP in contrast of given above Darwin's conclusion*!

In **Table 1**, it is seen that for macroscopic conditions, $R^*=R/r_f>100,000$, $I_{\text{elast}}=I_{\text{inelast}}=1$, therefore expression in the brackets of (33) also equal to 1. Thus the final formula, for $R^*=R/r_f>100,000$, takes the form

$$F_{\text{Gff}}^{\text{total}}=\frac{\pi\varepsilon_G\delta_a r_p^2 r_a^2}{4R^2}k\left(R^*,\delta_a\right). \tag{34}$$

Table 1. Results of calculations by (21), (27) and (35) for $\delta_a = \delta_p = 1.3\times10^{-41}$.

$R^* = R/r_f$	$k(R^*,\delta_a)$, f. (35)	I_{elast}, f. (27)	I_{inelast}, f. (21)
2	1.0×10^{40}	1.46329	1.00000
10	3.9×10^{38}	1.07166	1.00000
100	3.8×10^{36}	1.00712	1.00000
1000	3.8×10^{34}	1.00071	1.00000
10,000	3.9×10^{32}	1.00007	1.00000
100,000	3.9×10^{30}	1.00001	1.00000
1,000,000	3.9×10^{28}	1.00000	1.00000
…	…	…	1.00000
1×10^{17}	3.8×10^{6}	1.00000	1.00000
1×10^{18}	3.8×10^{4}	1.00000	1.00000
1×10^{19}	3.9×10^{2}	1.00000	1.00000
1×10^{20}	4.8	1.00000	1.00000
1×10^{21}	1.0	1.00000	1.00000

For distances $R^* = R/r_f > 100,000$ it is necessary to add multiplier I_{elast} calculated by (27) taking into account (28…32).

Since, accordance with [7] $\delta_a = 1.3\times10^{-41}$ and, $1/\delta_a \gg 1$, we may omit 1 in (9) and, taking into account also (7), finally to write

$$k\left(R^*,\delta_a\right) = 1 + \left(1-\sqrt{1-\left(r_f/R\right)^2}\right)\Big/\delta_a \,. \tag{35}$$

In **Table 1**, it is given results of calculations of the integrals I_{elast}, I_{inelast} and coefficient $k\left(R^*,\delta_a\right)$. The calculations were performed by the numerical method (by Simpson's formula) with the relative precision $\left(I_{\text{ekast } i} - I_{\text{ekast } (i-1)}\right)\big/I_{\text{ekast } i} < 0.00001$, where i is number of the calculation cycle.

Of course, results of the above numerical calculations are strongly depend from the numerical value of δ_a, which evidently has a smaller value, because the value $\delta_a = 1.3\times10^{-41}$ had been found very approximately in [7].

3. Strong Gravitation

As is seen from the table and **Figure 3**, when $R^* \to \infty$ coefficient $k\left(R^*,\delta_a\right) \to 1$. Practically when $R^* = 10^{21}$ we can consider this coefficient is equal to 1, but at short distances it has a very large value, and thus *gravitation becomes strong*. On the shortest distance $R^* = 2$ it is *comparable to electromagnetic and nuclear forces*. Unfortunately, we do not have reliable data on the size of the fundamental sub-particle, r_f Evidently, it is less of Planck's length, ~10^{-35} m.

The claimed in literature notion about a strong gravitation "constant", evidently, is not valid, inasmuch as actually the factor $k\left(R^*,\delta_a\right)$ is function of distance R. The production of the maximal value of $k\left(R^*,\delta_a\right) \sim 10^{40}$ on Newton's gravitation constant, *G*, *i.e.* $Gk\left(R^*,\delta_a\right) = 6.67\times10^{-11}\times10^{40} \sim 10^{30}$ m^3·kg^{-1}·c^{-2}, is comparable to numerical values of the "strong gravitational constants" given, for example, in [9] 3.9 × 10^{31} dyne·c^2·g^{-2} - 10^{28} m^3·kg^{-1}·c^{-2} and in [10] 10^{38} G - 10^{28} m^3·kg^{-1}·c^{-2} which had been found by another methods.

Thus, Newton's improved formula for the force of gravity can be represented as follows:

$$F = \frac{m_1 m_2 G}{R^2}\left[1 + \left(1-\sqrt{1-\left(r_f/R\right)^2}\right)\Big/\delta_a\right], \tag{36}$$

where r_f and δ_a are new constants, which must be found theoretically and experimentally.

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

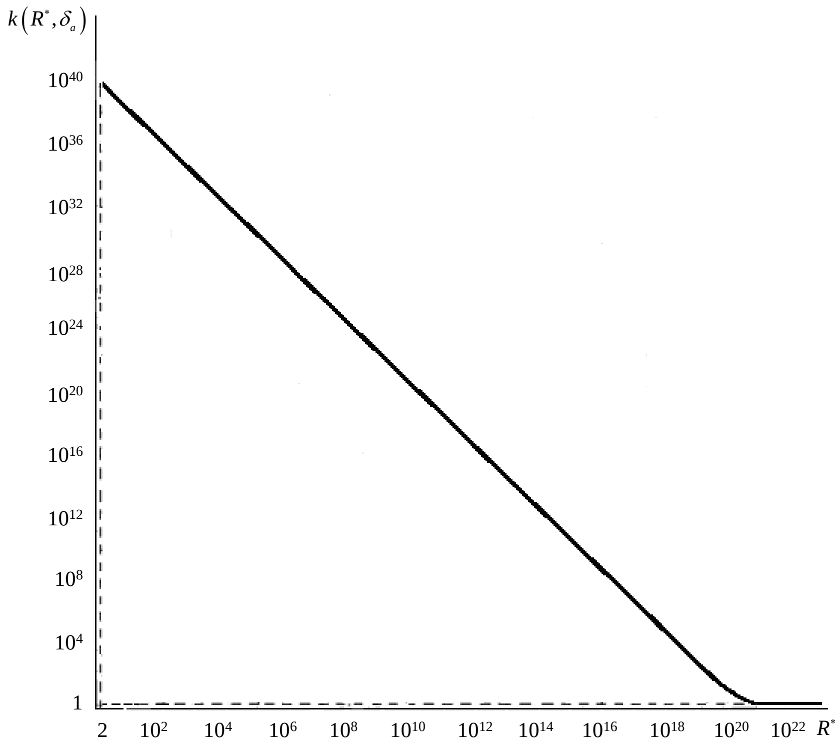

Figure 3. Diagram of dependence of the factor $k(R^*,\delta_a)$ from the ratio $R^* = R/r_f$ for $\delta_a = 1.3\times10^{-41}$.

4. Conclusions

An improved self-consistent model of the shadow-gravity has been developed and the exact formula for the shadow gravity force, for any including *short distances*, was derived. The obtained new formula for shadow-gravity force can be important for the particle physics theory and for unification of the *strong, electrical and gravitation* forces.

An important consequence of the derived exact formula here is the fact that the well known basic objection against the shadow-gravity (thermal problem) loses grounds. Poincaré have deduced, on Darwin's conclusion, that temperature of the Earth must be increase at 10^{26} degrees per second in result of absorption of fations. However this is so if the gravitation force is created only by inelastic collisions fations with body matter, as until now it was thought on Darwin's conclusion. Point is that Darwin does not take into account the flows of fations 3 (**Figure 1(a)** and **Figure 2(a)**) which are reflected from the active FSP (FSPa) and then come to the passive FSP (FSPp) from the right side. Having in mind this fact, as well as having considered elastic and inelastic collisions separately, I have shown *that the gravitational force is created only at the expense of the action of elastic collisions*, inasmuch as the inelastic part is counterbalanced by the negative term of the elastic one. Inelastic part of the force is considerably smaller than that of elastic. Indeed, from (20) and (33) it follows that the inelastic component makes up only $F_{\text{Gff}}^{\text{inelast}} / F_{\text{Gff}}^{\text{total}} = \delta_p \sim 10^{-42}$ part of the whole force and, therefore, bombarding the body fations. Thus, Poincaré's estimation must be corrected as $10^{26}\times10^{-42} = 10^{-16}$ degrees per second. During the existence of the Earth (~10^{17} seconds), its temperature must be increased, *in result of the fation absorption*, regardless of other well known factors, only to 10 degrees, thereby *the objection loses grounds*.

The new improved factor $k(R^*,\delta_a)$ for the strong gravity force is derived. Gravity force becomes strong beginning from the relative distance $R^* = R/r_f = 10^{20}$ and reaches $\sim 10^{40} F_{\text{Gff}}^{\infty}$ at the distance $R^* = R/r_f = 2$ between FSPs, where F_{Gff}^{∞} is the gravitation force for macroscopic conditions: practically at $R^* = R/r_f \geq 10^{20}$, when the factor $k(R^*,\delta_a)$ becomes equal to 1.0. Thus, at the distance $R^* = R/r_f = 2$ gravitation force becomes comparable to the electric and nuclear forces.

In the paper, the new important notion about *fundamental sub-particles* (FSP), from which all substances consist, is used. I suggest considering such sub-particles as fundamental, which are *absolutely impermeable* for fations.

Inasmuch as FSPs are in the sub-electron and sub-quark levels, their experimental detection presents a big problem.

It is possible, that the idea of shadow-gravity is confirmed by Podkletnov's experiments [11] subject to my interpretation of his results [12]. Unfortunately, it should be noted that no one can reproduce Podkletnov's experiment until now.

Finally, I would like to notice that, although we have made some arbitrary assumptions throughout the paper, these assumptions are justified out by the self-consistent model of the shadow-gravity and by important corollaries of the model.

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