the general science journal

From Newton and Bošković to the Recession in the Gravitational Formula

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Abstract: According to Haug's idea that Newton's gravitational constant, G [1] introduces confusion, and the views of Ruđer Bošković we show that the gravitational force has a repulsive part like other forces.

Keywords: Newton, Planck, Bošković, Haug, gravity, universe

Introduction

The idea came from Haug's article "***Newton Did not Invent or Use the so-Called Newton's Gravitational Constant G. Big G is not Needed in Physics; it Has Mainly Caused Confusion!".*** From we quote [2, p 8]: *Newton never mentioned a gravitational constant, himself. He calculated relative masses based on orbital time squared (and adjusted for distance between the gravity objects*).

Thus, the gravitational acceleration calculated by Newton would refer to the known acceleration: Take, for example, if we know the gravitational acceleration of the Earth, then the gravitational acceleration of the Sun is (1):

$$g_S = \frac{m_S}{m_Z} * \left(\frac{r_S}{r_Z}\right)^{-2} * g_Z = \frac{1,98910*10^{30}}{5,9736*10^{24}} * \left(\frac{6,96342*10^{8}}{6,37597*10^{6}}\right)^{-2} * 9,80661 = 273,771 m/s^2 \quad (1)$$

Thanks to Planck, we now have the advantage of expressing gravitational acceleration over his, let's call them, primary parameters of the universe. We will write gravitational acceleration by introducing a known relation; $G = l_{pl}^{3}*m_{pl}^{-1}*t_{pl}^{-2}$, we get (2):

$$g = m*m_{pl}^{-1}*l_{pl}^{3}*t_{pl}^{-2}*r^{-2} = \frac{m}{m_{pl}} * \left(\frac{r}{l_{pl}}\right)^{-2} * a_{pl} \qquad (2)$$

So, like Newton: we get relative masses, and also relative distances. That is: the gravitational acceleration is proportional to the ratio of the mass of the central body to the Planck mass and inversely proportional to the square of the ratio of the distance to the Planck length.

Formula (2) is identical to the much better known one, $g = Gm / r^2$, except that it does not cause confusion but immediately gives ideas for useful analyzes.

In formula (2), gravitational acceleration is expressed as a part of Planck acceleration which is the upper limit of possible acceleration in the universe [3]. However, the usual way of comparing elements is in relation to the average, and in a relative amount.

The acceleration is also desirable to compare with the average. For many fundamental physical parameters: the average is the geometric mean. The arithmetic mean becomes: only when it is logarithmic. Thus Planck's mass is the geometric mean of the masses in the universe and Planck's length is the lower limit of possible distances. There is an upper limit for each parameter, because if it were an infinite value, we would have an undefined state. Mean acceleration: (without attraction and repulsion) we take from [3, Table 1 and 1b]. The geometric mean of the acceleration in the system [kg-m-s] is: $\boldsymbol{a_o} = 6{,}95818 * 10^{-10} m / s^2$. Note here that for many other it also applies: $x_o = (x_{upperlimit} * x_{downlimit})^{0,5}$.

This value was obtained with the assumption that the whole of the universe is limited: not by our representation of spatial boundaries, but by the limitation of the phenomena that characterize it.

The unit acceleration depends only on two constants, the speed of light and the ***"Time cycle of the universe***", $T_u = 4{,}30849*10^{17}$ s, which is the famous 13.65 billion years, which are incorrectly called „***the age of the universe"***.

$$a_o = c / T_u = 6{,}95818 m * s^{-2} \quad (3)$$

Note that in natural units $\boldsymbol{a_o = 1}$, so that the acceleration can be **n** times greater than unity or for example **n** times less than unity, and by no means greater or less than zero. Also: $\boldsymbol{a_o}$ can be determined through many other constants that are known.

Now, instead of Planck's values, we apply a hypothetical fundamental particle of mass and radius: ($m_f = 1{,}08862*10^{-28}$ kg and $R_f = 3{,}23131*10^{-15}$ m), that, in addition to the property of no attraction and repulsion, also has other unique properties [4, f 3b and 4]. Note that:

$$m_f * R_f = m_{pl} * l_{pl} = \hbar/c$$

represents Planck values, We have:

$$g = \frac{m}{m_f} * \left(\frac{r}{R_f}\right)^{-2} * a_0 \qquad (4)$$

For example, let us calculate by formulas (2) and (4) the gravitational attraction on the surface of the Earth in the system [kg-m-s], (2b) and (4b).

$$g_{Zemlja} = \left(\frac{5,97356*10^{24}}{2,17651^{-8}}\right)*\left(\frac{6,37597*10^{6}}{1,616199*10^{-35}}\right)^{-2}*5,56092*10^{51} = 9,80661 m/s^{2} \quad (2b)$$

$$g_{Zemlja} = \left(\frac{5,97356*10^{24}}{1,08862*10^{-28}}\right)*\left(\frac{6,37597*10^{6}}{3,23131*10^{-15}}\right)^{-2}*6,95818*10^{-10} = 9,80661 m/s^{2} \quad (4b)$$

Or the results obtained with (2) and (4) are identical:

Everything written so far: is known. Even the relative relations of mass and radius in (2) or (4) that Newton could not know about because Planck discovered those quantities two centuries later. However, Newton still used relative amounts using the relationship between the planets and the Sun, which was abandoned by later "fixes of Newton's way"! [2].

In vector representation, there is an agreement: that attraction is negative and repulsion is positive. To satisfy this, we will not compare the acceleration to the unit, but vice versa: the unit to the acceleration. Thus: for further shortening, let us logarithm formula (4) to obtain more easily comparable amounts. With **lg** we denote the logarithm based on two ratios of unit acceleration to gravitational acceleration of the body, with **μ** the logarithm of the mass of the fundamental particle to the mass of the body and with **ρ** the ratio of the radius of the fundamental particle to distance, we get:

$$\lg = \log_2(a_0 / g) = \log_2(m_f / m) - 2*\log_2*(R_f / r) = \mu - 2\rho \quad (5)$$

We have obtained: a short dimensionless formula for gravitational acceleration. Let us apply this formula to the example of the planet Earth, $\mathbf{lg_{earth}}$, (5b):

$$lg_{earth} = \log_2\left(\frac{1,08862*10^{-28}}{5,97356*10^{24}}\right) - 2*\log_2\left(\frac{3,23131*10^{-15}}{6,37597*10^{6}}\right) = -175,19636 + 141,48203 = -33,714326 \quad (5b)$$

Of course, this dimensionless value for gravitational acceleration simply passes into the usual representation in [$m*s^{-2}$] by formula (6), let's check:

$$g_{earth} = a_0 * 2^{\lg earth} = 6,95818*10^{-10} * 2^{-33,714326} = 9,80661 m/s^{2}$$

(6)

It means: that everything previously differs only in the way of presenting one and the same phenomenon, gravitational acceleration.

The goal of the entire previous presentation was to show gravitational acceleration in a form that will not bring confusion and will not obscure the simplicity of Newton's approach, but also the approach of another philosopher of nature from Newton's time, Ruđer Bošković. Namely, what can be seen in formulas (2) or (4), has long been described in Bošković's capital work, "***Theoria philosophia naturalis redacta ad unicam legem virium in natura existentium***", [5]. From there: in the next chapter, we will highlight the most important passages for this paper.

Bošković's understanding of acceleration in nature

Let us quote from the introduction of the English translation of Bošković's:
*The mutual **vires**, ascribed by Boscovich to his pairs of points, are really accelerations, i.e. tendencies for mutual approach or recession of the two points, depending on the distance between the points at the time under consideration.*

And ahead:
To sum up, it would seem that the curve of Boscovich is an acceleration-interval graph; and it is a mistake to refer to his cosmic system as a system of „force-centres".

We will accept this in such a way that we perform calculations by accelerations, not by forces.

Note: no galaxies were known in Bošković's time. Let us show Bošković's Figure 1. [5].

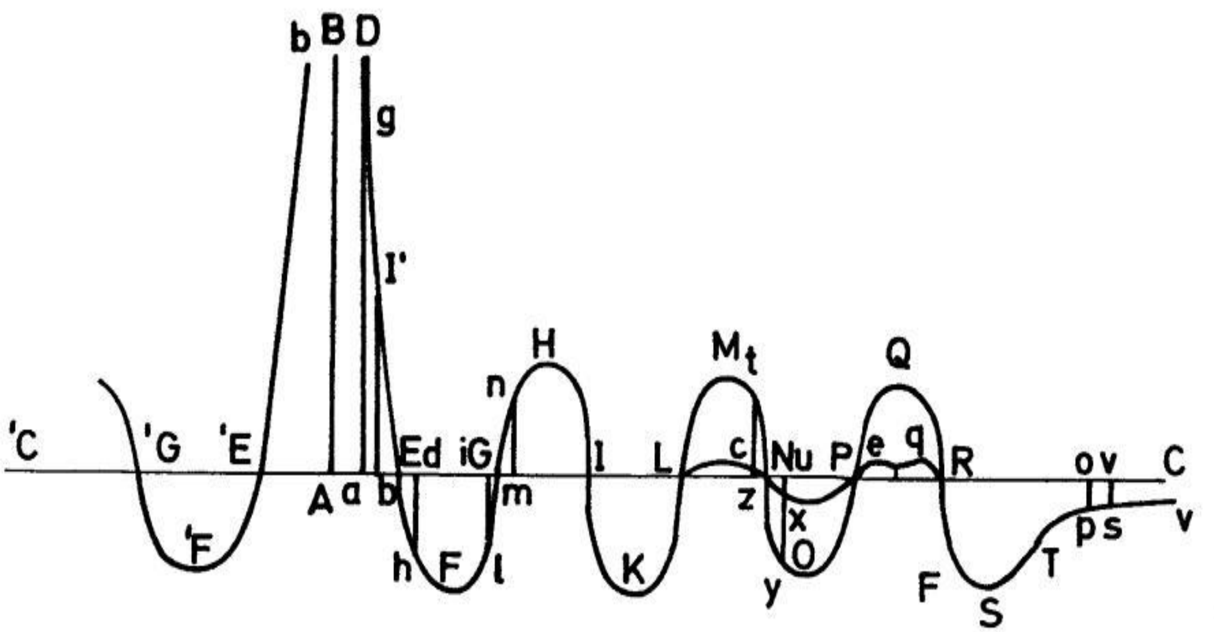

Figure 1 - General shape of the Bošković curve showing the change of the attractive and repulsive force with the change of the distance (abscissa)

The force can be attractive or repulsive, depending on the distance. The abscissa represents the value of acceleration on which there is neither attraction nor repulsion.

Since this paper deals only with gravity, let us quote Bošković on this issue, in relation to Figure 1 from [2, paragraph 12]:

The form of the curve.

12. ... *Finally the arc of the curve ends up with the other branch TpsV, lying on the opposite side of the axis with respect to the first branch; and this second branch has the axis itself as its asymptote, & approaches it approximately in such a manner that the distances from the axis are in the inverse ratio of the squares of the distances from the straight line AB.*

Bošković, like some others, believes that Newton's law of gravitation is not ideally correct; see [6, *Extensions*].

We consider that all the previous formulas refer to the square of the distance and that the existence of forces with a different exponent is not the subject of this paper.

Bošković also says:

The ultimate arc representing gravity possibly not asymptotic.

170. If universal gravity obeys the law of a force inversely proportional to the square of the distance (which, as I remarked in the first part, it only obeys as nearly as possible, but not exactly), sensibly unchanged only throughout the planetary & cometary system, it will certainly be the case that the curve of forces will not have the last arm PV asymptotic with the straight line AC as the asymptote, but will again cut the axis & wind about it.

Wind about it means: that attraction and repulsion will shift. Fact: that Bošković in paragraph 12 limited himself to the attractive part of gravity means that in Figure 1 he adhered to the facts known up to that time, while in paragraph 170 he anticipated the existence of now known large cosmic structures.

In Figure 1: Bošković did not indicate that the abscissa has a value of zero. Newton also sees the gravitational force in a relative relation: so that any division by zero would be undefined. Later, there was confusion due to the expectations of many: to attribute zero value to force and acceleration. Formula (5), which essentially introduces nothing new, meets these expectations. Since the logarithm, the quotient turned into subtraction, in (5) the possible value of zero is in the case, $\boldsymbol{\mu = 2\rho}$. That formula is in accordance with Bošković's views set out in paragraph 170, which is also in line with my theory of "*The Theory of Unity of the Whole and its Parts*" [7].

So it follows: that the value of the logarithmic gravitational acceleration expressed by formula (5) can take values greater than and less than zero, that is: to describe both attraction and repulsion. The final consequence is: Newton's gravitational formula describes both attraction and repulsion, only it is obscured by the introduction of a universal gravitational constant, G.

Gravitational acceleration of planets

Applying formulas (5) and (6) by the example of the planets of the solar system, we obtain:

Table 1 Gravitational acceleration

	l_{pl} =	m_{pl} =	System [kg - m - s]			a_{pl} =
	1,616E-35	**2,17651E-08**				**5,56092E+51**
Fund.p.	3,231E-15	1,088622E-28		**$a_o=(m_f/m_{pl})*(R_f/l_{pl})^{-2}*a_{pl}$ =**		**6,95818E-10**

Planets	radius	mass	μ	-2ρ	*lg* = μ -2ρ	$g=a_o*2^{\wedge-lg}$
Mercury	2,440E+06	3,302200E+23	-171,01926	138,71015	-32,30911	3,702593
Venus	6,052E+06	4,868500E+24	-174,90124	141,33147	-33,56976	8,871591
Earth	6,376E+06	5,973600E+24	-175,19636	141,48203	-33,71433	9,806608
Mars	3,396E+06	6,418500E+23	-171,97807	139,66459	-32,31348	3,713834
Jupiter	7,149E+07	1,898600E+27	-183,50848	148,45616	-35,05232	24,791002
Saturn	6,027E+07	5,684600E+26	-181,76867	147,96338	-33,80529	10,444841
Uranus	2,556E+07	8,681000E+25	-179,05755	145,48826	-33,56929	8,868650
Neptune	2,476E+07	1,024300E+26	-179,29625	145,39709	-33,89917	11,147079

- We could take the MOND value $a_o = 1{,}2*10^{-10}$ ms^{-2}, [8] instead of mine, or often used in MOND, $2\pi * a_o = 7{,}54 * 10^{-10}$ ms^{-2}, so to perform calculations in relation to those values, with the same results.
- The determination for the value $a_o = 6{,}695818 * 10^{-10}$ ms^{-2} is caused by the fact that through the hypothetical fundamental particle it has numerous relations in both cosmic and quantum proportions.
- In any case, this parameter exists, is extremely important and everyone can suggests and explain their value for a_o.
- For the purpose of showing the existence of repulsion in gravitaty, the exact value of a_o is not crucial.
- The gravitational acceleration in the last column agrees with the known values.
- If we calculate so that **μ = 2ρ** we get radii above which, the gravitational acceleration of the planet turns into repulsion. That is, translated into meters, the attraction turns into repulsion at a distance $\mathbf{R} > \mathbf{R_f * 2^{\wedge-\mu/2}}$, ($\mathbf{R_f} = 3{,}23131*10^{-15}$ m).

Galaxy Recession

Formula (5): applied to galaxies shows the recession of mutually distant galaxies.

Imagine: a galaxy of mass 10^{41} kg as in Table 2. Let us define a galaxy: bounded by attraction, that is, the gravitational acceleration of the galaxy's circumference is, a_o, the distance R_g in the second column.

Table 2 Galaxy recession

	$R_g=R_f*2^{-\mu/2}$	mass	μ	-2ρ	*lg* = μ -2ρ	$g=a_o*2^{-lg}$
Galaxy	9,794E+19	**1E+41**	-229,09054	229,09054	0,00000	**6,95818E-10**

Speed recession of galaxies is then:

$$V=\sqrt{D*a_o}=c*\sqrt{D/R_u} \qquad (7)$$

D – Txe distance between galaxies**,** R_u **-** The radius of the universe**.**

Thus: from Newton's gravitational acceleration we get the expression for the recession of galaxies depending on the distance between them, which is different from Hubble's law [9]. And both are special cases in relation to those described in [5, after paragraph 170].

It is obvious from (7): that the speed of repulsion depends only on the distance. Let's show three examples of the distance from the galaxies. We see that the speed increases with distance:

D	$V = (D * a_o)^{0,5}$
1E+20	**2,6378E+05**
1E+23	**8,3416E+06**
1,292E+26	**2,9979E+08**

In the third row, the distance $D = R_u = c * T_u$, the upper limit of the distance in the universe, where the speed of recession is obtained equal to the speed of light. Consideration of this result would take us: from the topic of this paper, whose only goal is to show the existence of a repulsive part of gravitational acceleration, that is, multiplied by some mass, Newton's gravitational force.

Conclusion

It is shown: The gravitational force has an attractive and repulsive part as well as other forces, which is hidden after Newton by the introduction of "Newton's gravitational constant", G [1].

References:

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