Gravitational Constant Puzzle

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Abstract

Gravitational constant defines a numeric value of the force of attraction between objects with mass (or energy) separated by some distance. This value was determined by experiments with massive lead bodies on torsion scales. The experiments cannot be particularly accurate because gravity is substantially weaker (10^{36} times) than electromagnetism – the main force in the torsions. Thus finding the value of the Gravitational Constant with a theory based on numerical calculation is justified.

It is shown in the article that the Gravitational Constant can be assembled as a puzzle from fundamental physical and math constants as follows:

$$G = \left(\frac{2\cdot\pi}{137^2}\right)^{11} \cdot \frac{\hbar\cdot c}{m^2} \qquad (1)$$

where G is the Gravitational Constant,

$\hbar$ - reduced Planck constant,

c - speed of light,

$m = (m_n + m_p + m_e)/2$ – average mass of neutron and proton + electron pair.

Numerically, the expression ***(1)*** yields $6.67409850(8)\cdot 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$ with relative uncertainty 10^{-8} mostly attributed to the deviation of the reduced Planck constant.

Does formula tell us about 11 dimensions? Does it link the gravitation to electromagnetism due to presence of number 137 known to all physicists as integer portion of the Fine Structure constant reciprocal? The author is still puzzled: why the force of Gravity can be expressed with great accuracy via the above physical and math constants? Nevertheless – there is a theory behind the formula.

Method of Derivation of the Gravitational Constant

Using Einstein's Mass-Energy Equivalence $E = M \cdot c^2$ and the potential energy of Gravitation $E = G \cdot M^2 / L$ where M is the mass of the Universe and $L = c \cdot t$ is the size of the Universe equal to the product of c - speed of light and t - time (age of Universe) we can obtain expression ***(2)***:

$$Mc^2 = G\frac{M^2}{c \cdot t} \tag{2}$$

which after simplification immediately gives formula ***(3)***

$$M = \frac{c^3}{G} \cdot t \tag{3}$$

for the expanding[1][2] Universe's mass M growth with time t.

The rate of growth is equal to

$$\frac{dM}{dt} = \frac{c^3}{G} \tag{4}$$

During the process of mass creation the newly born particles should be electrically neutral like neutron. Let's calculate first the ratio of neutron mass to its reduced Compton time:

$$\frac{dm_n}{dt_{compton}} = \frac{m_n^2 \cdot c^2}{\hbar} \tag{5}$$

Divide formula ***(5)*** by ***(4)*** and get dimensionless gravitational coupling constant ***(6)***:

$$\frac{m_n^2 \cdot G}{\hbar \cdot c} = 5.9 \ldots 10^{-39} \sim \left(\frac{2 \cdot \pi}{137^2}\right)^{11} \tag{6}$$

The numerical value $5.9\ldots \cdot 10^{-39}$ is calculated from experimental data for physical constants participating in the formula's ***(6)*** left side.

The numerical expression on the right side of the formula ***(6)*** has been found by next method.

A. If Gravity is related to electromagnetism with its characteristic Fine Structure constant $\alpha = \frac{1}{137} \cdot \left(1 - \frac{1}{2} \cdot \frac{\pi^2}{137^2} + \cdots\right)$ then it is possible to calculate how many times coefficient $\frac{\pi^2}{137^2}$ needs to be multiplied to itself to be closest to the gravitational coupling value of ***5.9…·10^-39^*** but not below it. The answer is ***11***.

B. $$\left(\frac{\pi^2}{137^2}\right)^{11} = 8.5\ldots\cdot 10^{-37}$$

C. The remaining value $5.9\ldots\cdot 10^{-39} / 8.5\ldots\cdot 10^{-37} = 6.94\ldots\cdot 10^{-3}$ itself could be power of ***11***.

It is indeed $6.94\ldots\cdot 10^{-3} = \left(\frac{2}{\pi}\right)^{11}$

D. Thus gravitational coupling constant value can be expressed as

$$5.9\ldots\cdot 10^{-39} = \left(\frac{\pi^2}{137^2}\right)^{11}\cdot\left(\frac{2}{\pi}\right)^{11} = \left(\frac{2\cdot\pi}{137^2}\right)^{11}$$

For more accuracy, instead of neutron mass m_n it is better to use average mass between neutron m_n and proton + electron pair mass $m_p + m_e$ because atoms consist of neutrons, protons and electrons.

$$\frac{((m_n+m_p+m_e)/2)^2\cdot G}{\hbar\cdot c} = \left(\frac{2\cdot\pi}{137^2}\right)^{11} \qquad (7)$$

The result matches to the experimental measurements of all physical values in the left part of formula ***(7)*** with relative precision 10^{-8}. Then Gravitational constant G is extracted from equation ***(7)*** to obtain formula ***(1)***.

Additionally, considering that $137^2 \sim \alpha^{-2} - \pi^2$ where α is the Fine Structure constant the expression ***(1)*** for the Gravitational constant can be alternatively written as

$$G = \left(\frac{2\cdot\pi\cdot\alpha^2}{1-\pi^2\cdot\alpha^2}\right)^{11}\cdot\frac{\hbar\cdot c}{m^2} \qquad (8)$$

Formula ***(8)*** shows that gravity constant could take value of ***0*** if electromagnetic coupling constant α would be ***0***. It means the gravity is a residue of electromagnetism: no electricity – no gravity.

The Gravitational constant could also be negative if α would be bigger than ***1/π.*** Likely the Fine Structure constant lies in between ***0*** and ***1/π*** – namely $\alpha = 0.00729735\ldots$ and all objects still attract each other.

References

1. Guth, Alan (15 January 1981). *"Inflationary universe: A possible solution to the horizon and flatness problems"*. Phys. Rev. D **23** (2): 347–356. *Bibcode*:*1981PhRvD..23..347G*. *doi*:*10.1103/PhysRevD.23.347*.

2. Livio, Mario (2001). The Accelerating Universe: Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos. John Wiley & Sons. p. 160. *ISBN* *047143714X*.