THE MYSTERY OF THE GRAVITATIONAL CONSTANT G: The greatest metrological dead end in history or proof that gravity is more complex than Newton thought?

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Abstract. *The "Big G" problem remains an unsolved mystery in modern metrology and physics. Scientists have yet to obtain a precise value for the gravitational constant. Various laboratories use impeccable equipment that achieves record-breaking measurement accuracy, yet their results consistently diverge beyond the permissible error margins. It is shown here that the problem of the gravitational constant G is directly related to the incompleteness of the Newtonian model of gravity. The gravitational constant G refers to the gravity of the entire universe—this is its fundamental meaning. However, "Big G" is calculated from Newton's law of gravity, which does not take into account the gravity of the universe. Using the local law of two-body gravity F = GmM/r^2 without taking into account the gravity of the enormous mass of the universe leads to an error. To eliminate this error, it is proposed to use the law of gravity FU = GmM/r^2 + (mc^2)√Λ, which takes into account the gravity of the universe. It has been shown that the discrepancy between the values of G lies in the fact that the second component of the gravitational force, (mc^2)√Λ, is not taken into account when calculating it. This leads to a shift in the values of G by varying amounts, depending on the contribution of the second component, (mc^2)√Λ. The measured value of the constant G depends not only on technical limitations but also on how adequately the physical law from which it is calculated describes gravity.*

Keywords: *gravity; gravitational constant; cosmological constant; the "big G" problem; the Universe; the Great Attractor; astronomy; Newton's law of gravitation.*

1. Introduction

The results of a decade-long experiment conducted by the National Institute of Standards and Technology (NIST), published on April 16, 2026, failed to resolve the mystery of the gravitational constant G [1]. This time, the obtained value differs from the previous reference measurement by 0.0235%. Such a discrepancy is a catastrophically large amount for fundamental physics. Different laboratories use impeccable equipment that provides record-breaking measurement precision, but their results consistently diverge beyond the permissible error margins. These results have definitively cemented the gravitational constant's status as the most problematic fundamental constant in modern physics. What is this? A consequence of unaccounted for systematic experimental errors or a sign of the incompleteness of our fundamental theories of gravity? "We now have 17 measurements of G, and they still scatter more than they should. Nobody knows why," S. Schlamminger said.

This impasse points to a deeper, systemic issue with our understanding of gravity. Here we show that the discrepancy between the values of big G and the permissible errors is directly related to the incompleteness of the Newtonian model of gravity.

2. Incompleteness of the Newtonian model of gravity.

The theoretical basis for deriving the value of the gravitational constant G is Newton's law $F = GmM/r^2$. Newton's formula is a mathematical model of two-body gravity. Newton's law "does not recognize" the actual gravitational force exerted by all N bodies in the Universe. For many practical applications on Earth, this law was sufficient. However, the predictions of Newtonian gravity do not hold at the scale of the Universe [2–8]. Newton's formula describes the gravity of a single local source of attraction and does not take into account that bodies are simultaneously attracted to all other bodies in the Universe. From such an idealized, simplified, and approximate mathematical model of gravity, it is impossible to obtain an exact value for large G.

The gravitational constant G applies to the gravity of the entire Universe, so its value must follow from a physical law that adequately, and not simplistically, describes the gravity of the Universe. The two-body law of gravitation, $F = GmM/r^2$, provides an idealized and oversimplified description of the real gravity of the Universe. In nature, there is no isolated gravitational interaction between two bodies. Gravity always involves all bodies in the Universe. Isolated two-body systems do not exist in physical reality. Every body in the Universe is in a web of gravitational connections with every other object. Any two bodies participating in a gravitational interaction are subject to the gravitational forces of all other bodies in the Universe. Newton's law of gravitation, $F = GmM/r^2$, does not take into account the collective gravitational interaction of all bodies in the Universe.

The primary reason for the discrepancy between measured values of the fundamental constant G lies not in a hidden systematic error in the instruments, but in the fact that Newton's formula, as a mathematical model of gravity, describes a hypothetical gravitational situation and "blinds" the gravitational forces of all other bodies in the Universe. From an approximate law of gravitation, one can only obtain an approximate value for the fundamental constant G.

3. When does Newton's law of gravity fail?

Newton solved the two-body gravitational problem. He solved a specific mathematical problem about how two isolated masses interact. In nature, there are no masses isolated from gravity [9]. Newton did not use the constant G in his law of gravity. It appeared in physics 200 years later. Calculating the constant G from Newton's law gave rise to the "big G" problem. The history of science is replete with cases where calculations based on Newton's law have failed scientists.

Relying on Newton's law of universal gravitation, W. Le Verrier attempted to explain the anomalous precession of Mercury's perihelion [10]. He proposed the existence of an invisible planet, Vulcan, located closer to the Sun, which turned out to be a mistake. W. Le Verrier's belief in the universality of Newton's law of universal gravitation led him to the false conclusion about the existence of Vulcan.

The history of the emergence of dark matter in science is similar to the history of the Vulcan hypothesis. In the 1930s, Fritz Zwicky noticed that galaxies were moving too fast—as if there was much more mass there than we could see. Newton's law, $F = GmM/r^2$, was traditionally understood, as its name suggests, as the law of universal gravitation. Therefore, Fritz Zwicky, believing in the universality of Newton's law, applied it to the galaxy and called the invisible mass dunkle Materie [11]. Even earlier, in 1904, excessive faith in Newton's law had led Lord Kelvin astray [12]. Trying to estimate the mass of the Milky Way, he concluded that there were "dark bodies" that we cannot see, but which create additional gravity. The existence of these "dark bodies" followed from Newton's law of universal gravitation to balance the calculations. The French mathematician and physicist An. Poincaré criticized Kelvin's proposal. His verdict was: "There is no dark matter, or at least not as much of it as visible matter" [13].

Vera Rubin's research in the 1970s showed that the outer parts of spiral galaxies rotate too rapidly, contrary to Newton's laws of mechanics [8]. Rubin concluded that dark matter exists. She reached this conclusion by attempting to apply the law of gravity $F = GmM/r^2$ to a galaxy beyond its applicability.

It is not surprising that attempts to obtain an exact value of G from the approximate law of two-body gravity encounter insurmountable difficulties. We see the solution to the problem of "big G" in using, instead of Newton's law, a new law of gravity that takes into account the gravity of the entire Universe.

4. To calculate "Big G," instead of a local law of two-body gravity, a physical law describing the gravity of the entire Universe is needed.

"Big G" is one of the fundamental constants of nature and applies to the entire universe. The constant G itself is a parameter of the universe. However, the measurements are carried out without taking into account the gravity of the Universe under local conditions, using Newton's law. "Big G" is not a localized constant, but a global one, inextricably linked to the mass and energy of the entire universe. Therefore, to calculate it, we need a physical law describing the gravity of the universe.

When we shift the focus from "bad instruments" to "incomplete physics," we cannot help but touch upon several theoretical models. For example, in the Brans-Dicke model, the fundamental constant G is determined from the average mass density in the Universe. Mach's principle implies that Newton's law of universal gravitation is fundamentally incomplete. At the end of the 19th century, physicist and philosopher Ernst Mach put forward a revolutionary idea: local properties of matter, such as inertia and mass (and, consequently, gravitational interaction) are determined by the combined gravitational influence of all masses in the Universe. This means that G must follow from the gravitational force of all bodies in the Universe, and not from the idealized law of two-body gravity $F = GmM/r^2$, which is not applicable to the Universe.

Many renowned scientists have pointed out the connection between the constant G and the parameters of the Universe. Erwin Schrödinger attempted to mathematically formulate Mach's principle and, as early as 1925, proposed the equation:

$$\mathbf{Mu\ G = c\^{}2\ Ru} \qquad (1)$$

Where: Mu is the mass of the Universe, G is the gravitational constant, c is the speed of light, and Ru is the radius of the Universe.

Equation (1) relates G to the mass and radius of the Universe [14]. A similar equation, **Mu G = c^2 Ru**, was obtained by Bleksley [15]. Milne proposed the following equation in 1936 [16]:

$$\mathbf{Mu\ G = c^3 Tu} \qquad (2)$$

Where: Mu is the mass of the Universe, G is the gravitational constant, c is the speed of light, and Tu is the time of the Universe.

Stewart discovered an equation relating the gravitational constant to the Hubble parameter [17, 18]:

$$\frac{Gm_e^2}{r_e} = \alpha^2 \hbar H \qquad (3)$$

Where: me is the electron mass, G is the gravitational constant, re is the electron radius, α is the fine-structure constant, ћ is Planck's constant, and H is the Hubble parameter.

The relationship between the gravitational constant, the parameters of the Universe, and the constants of the electron was pointed out by Dirac, Rice, Teller, and Weinberg. Dirac's equation [19, 20] is:

$$\frac{m_e c^3}{He^2} = \frac{\alpha e^2}{Gm_e^2} \qquad (4)$$

Where: me is the electron mass, e is the electron charge, c is the speed of light, G is the gravitational constant, α is the fine-structure constant, ɦ is Planck's constant, and H is the Hubble parameter.

Weinberg's equation [21] has the form:

$$\hbar^2 H \alpha^3 = Gcm_e^3 \qquad (5)$$

Where: me is the electron mass, c is the speed of light, G is the gravitational constant, α is the fine-structure constant, ћ is Planck's constant, and H is the Hubble parameter.

Teller's equation [22] has the form:

$$\frac{G\hbar H}{c^4 l_{Pl}} = t_{Pl} H \qquad (6)$$

Where: c is the speed of light, G is the gravitational constant, lPl is the Planck length, tPl is the Planck time, ɦ is Planck's constant, and H is the Hubble parameter.

Rice discovered equation [23] linking the gravitational constant to the radius of the universe and the electron constants:

$$\frac{R_U G m_e}{r_e^2 c^2} = \alpha \qquad (7)$$

Where: me is the electron mass, c is the speed of light, re is the electron radius, G is the gravitational constant, α is the fine-structure constant, and Ru is the radius of the universe.

Both Mach's principle and the close connection of G with the parameters of the Universe indicate that the constant G must be calculated from the force of gravitational interaction of all bodies in the Universe and not from law of gravity of two bodies.

5. The "big G" problem is not a metrological dead end, but a consequence of the incompleteness of the Newtonian model of gravity.

If we assume that physicists have measured everything correctly over dozens of experiments, but used the classical formula $F = GmM/r^2$, which does not include the force due to the gravity of the entire Universe, then we may end up with a coefficient close to G, rather than the constant of the

Universe itself. This fundamentally changes the essence of the problem. The hypothesis that the spread of G values is not a metrological dead end, but a signal of the incompleteness of the Newtonian model of gravity, allows us to uncover the deep roots of this problem.

Newton's equation $F = GmM/r^2$ is formulated as if there were only two bodies in the Universe. A laboratory experiment measuring "big G" also models the gravity of only two isolated bodies. Trying to separate two bodies from the rest of the cosmos is an abstraction that departs from reality. If we calculate a fundamental constant based on an artificially isolated force between two bodies (which does not exist in its pure form in nature), the mathematical basis for the calculations itself may contain a systematic flaw, resulting in an inaccurate, "distorted" number. When attempting to calculate G using the Newtonian force, physicists use a formula that only approximately describes physical reality. Using the formula $F = GmM/r^2$ in metrology leads to a fundamental methodological impasse. By attempting to calculate a constant using an equation that is initially only an approximation, physicists inevitably obtain an inaccurate number.

Since Newton's law is fundamentally incomplete and does not take into account the cosmological scale, when using it, we obtain not the fundamental constant of the Universe ("big G"), but a "coefficient" close to its value for isolated bodies in absolutely empty space. This is the profound conceptual conflict between Newton's local physics and the gravitational interaction of all bodies in the Universe. The law $F = GmM/r^2$ was originally formulated for isolated bodies in absolutely empty space. Such a gravitational situation does not exist in nature. This is a fundamental limitation of the Newtonian approach: it is impossible to measure the constant G with absolute precision in a local experiment, completely disregarding the fact that the experiment itself is conducted within the unified gravitational field of the Universe.

6. New law of gravity for calculating Big G, taking into account the gravity of the Universe.

To fully describe gravitational interactions, the law of gravity must include the parameters of the Universe. Newton's formula does not. What is commonly considered the Newtonian force does not contain the actual cosmological force of the Universe, which is necessary to calculate the gravitational constant G. When calculating the gravitational constant G, it is proposed to use the law of gravity, which takes into account the gravity of the Universe (Fig. 1), instead of Newton's law [24 - 28]:

$$F_U = \frac{GmM}{r^2} + mc^2\sqrt{\Lambda}$$

Fig. 1. The law of universal gravitation taking into account the gravity of the Universe. Where: m and M are the masses of the bodies, r is the distance, c is the speed of light in a vacuum, G is the gravitational constant, and Λ is the cosmological constant.

The first part of the equation includes two interacting masses, and the second part of the equation, $(mc^2)\sqrt{\Lambda}$, accounts for the cosmological force acting on any body from the entire Universe

[24 - 28]. From the new law of gravity, $FU = GmM/r^2 + (mc\char`^2)\sqrt{\Lambda}$. it follows that the gravity of any two bodies is always complemented by the gravity of the Universe. The new law of gravity takes into account the additional background gravity of the Universe. A different formula for calculating G follows from the equation $FU = GmM/r^2 + (mc\char`^2)\sqrt{\Lambda}$. The equation (Fig. 1) shows that using one component of GmM/r2 to calculate the fundamental constant G without taking into account the gravity of the Universe $(mc\char`^2)\sqrt{\Lambda}$ yields an erroneous value of G.

The new mathematical model of gravity $FU = GmM/r^2 + (mc\char`^2)\sqrt{\Lambda}$ yields results close to Newton's formula only on the scale of planetary systems, but fundamentally diverges from it both on the scale of the Universe and at small masses and short distances. Experiments to determine the value of the fundamental constant G model the idealized gravitational interaction of two isolated small masses at short distances.

The gravity of the Universe generates additional acceleration [24 - 28]:

$$\mathbf{Ao = (c\char`^2)\sqrt{\Lambda}} \qquad (8)$$

Without taking this additional acceleration into account, the value of "Big G" turns out to be higher than the real one in all experiments.

7. Acceleration ($Ao = (c\char`^2)\sqrt{\Lambda}$), which Earth-based instruments fundamentally "don't see."

Accelerations in torsion balances are close to the critical threshold, where background acceleration from the masses of the Universe can influence the measurement result. At first glance, the acceleration $Ao = (c\char`^2)\sqrt{\Lambda}$ due to the mass of the Universe may seem negligible due to the vast distances involved. In fact, this is not the case [24 - 28]. The law of gravity, which takes into account the gravity of the Universe, yields the value: $Ao = 10.4922... \cdot 10^{-10}$ m/s² (Fig. 2).

$$Ao = c^2\sqrt{\Lambda} = 10.4922... \cdot 10^{-10}\ \text{м/с}^2$$

Fig. 2. Acceleration due to the mass of the Universe. Where c is the speed of light in a vacuum, and Λ is the cosmological constant.

The acceleration imparted by external gravitational masses to the internal test masses in the NIST/BIPM setup is extremely small, about 10^{-7} m/s². A torsion balance must measure such a small acceleration, $\sim 10^{-7}$ m/s², with high accuracy in the presence of a cosmological acceleration of $\sim 10^{-9}$ m/s². A torsion balance does not "see" the cosmological acceleration directly, but its indirect influence on the value of the constant G remains. This means that the value $Ao = 10.4922... \cdot 10^{-10}$ m/s² can influence the resulting acceleration to 4th or 5th places. The acceleration value ($Ao = (c^2)\sqrt{\Lambda} = 10.4922... \cdot 10^{-10}$ m/s²), obtained from the equation $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$, turned out to be very close to the MOND prediction [2]. In modern physics, an acceleration of 1.2×10^{-10} m/s² is known as the critical acceleration in modified Newtonian dynamics (MOND). It is at this threshold that Newton's laws cease to apply at the edges of galaxies.

Failure to account for the acceleration caused by the mass of the Universe biases the measurement results by a fixed amount. If a physicist thinks they are measuring G as a constant of the Universe, but when calculating it, they fail to account for the acceleration caused by the mass of the Universe, then the calculated value of G will be biased across the entire series of experiments.

8. The second component of the gravitational force ($mc^2\sqrt{\Lambda}$) as an unaccounted factor in the calculation of "big G"

The equation $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$ shows that the cosmological force vector of the Universe must be taken into account when calculating G. In experiments measuring G, the measuring instrument is located in the "falling elevator" called Earth, and therefore does not directly "sense" the "vector of the Universe". If the instrument is fundamentally blind to some external factor, but this factor is necessary when calculating G, then scientists will get a distorted result and will not even understand its origin. From the equation $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$, it follows that this external unaccounted factor is the additional gravitational force of the Universe. The reason for the discrepancy in the values of large G is that when calculating it, the second component of the gravitational force is not taken into account: $(mc^2)\sqrt{\Lambda}$. The acceleration caused by the mass of the Universe acts as a hidden shift. At NIST, they remove all the noise, obtaining a beautiful, stable number. In China, they do the same thing, but their "elevator" is tilted differently to the vector of the Universe. The Chinese also obtain a beautiful, stable line—but at a different point on the graph.

The acceleration caused by the mass of the entire Universe is directed at a different angle in each laboratory to the Earth's rotation axis and to the local "small g" vector. The torsion balance at BIPM is oriented differently in space than at NIST. If the Universe's field is not perfectly isotropic, this difference in orientation angles will create a constant but hidden difference in the final figures. A gravitational anomaly has been discovered in the Universe. This is the Great Attractor, discovered by the Seven Samurai group. [29].

Laboratory instruments are not directly sensitive to either the gravitational anomaly or the cosmological force vector. The torsion balance is insensitive to the cosmological force vector because the measuring instrument, the laboratory, the Earth, the Solar System, and the entire Galaxy are in a state of constant free fall in the gravitational field of the Universe. Inside a system in free fall, the external gravitational field is not felt. However, it is real, and its influence on the results of G calculations must be taken into account. As a theoretical basis for calculating G, instead of Newton's law, it is necessary to use the law of gravity $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$, which takes into account the gravity of the Universe (Fig. 1).

9. Vector of cosmological force.

The constant G in a local experiment is always destined to be the result of complex mathematical filtering, where physicists attempt to "subtract" the influence of noise. The gravity of the Universe is also unjustifiably considered noise. Mathematical filtering is the stage of calculating the gravitational constant G that eliminates terrestrial and cosmic interference, but it ignores the fundamental limitation of the Newtonian approach. Physicists use filters to fit data to Newton's equation. However, this equation itself is only an approximate description of gravity. It describes an idealized gravitational interaction between two bodies, ignoring the gravity of other bodies, which is not observed in nature. Newton's formula does not contain the cosmological force $F_{Cos} = (mc^2)\sqrt{\Lambda}$, which always complements the Newtonian force [24].

The cosmological force vector has a unique feature: it is constant in both magnitude and direction in space. The measuring device physically rotates with the Earth, causing its orientation relative to outer space to change. The gravity of outer space never disappears, but the measuring device cannot detect it. This is the component of the invisible force that must be taken into account when calculating the gravitational constant G according to the formula $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$.
The contribution of the acceleration due to the mass of the Universe varies and depends on the orientation of the torsion balance relative to the cosmological force vector. One laboratory subtracts slightly more, another slightly less. The result is the very same "spread" in results that has kept the fundamental constant G from being definitively determined.

Metrologists have fallen into a logical circle:

1. To calculate the fundamental constant of the Universe, they took as a basis Newton's formula, which does not take into account the gravity of the Universe.

2. They used this formula to create a torsion balance, which is physically blind to the cosmological force of the Universe $F_{Cos} = (mc^2)\sqrt{\Lambda}$.

3. Based on the data from this device, they calculate the most important parameter of the Universe (Big G), despite the fact that the torsion balance does not record the gravity of the Universe.

4. When the results at different points on the planet don't agree, they claim errors in filtering out local noise, categorically refusing to admit that the device has cut out the global cosmological variable that modulates local gravitational interactions.

5. The cosmological force vector was not paid attention to and was not included in the gauge equations for the reason that it is not in Newton’s law.

6. This is an unsuccessful attempt to derive a high-precision value for "big G" from an approximate law of gravity that describes the isolated gravitational interaction of two bodies that does not exist in nature.

7. It failed to take into account that the measured value of G depends not only on technical limitations, but also on how adequately the physical law from which it is calculated describes gravity.

10. Throwing the baby out with the bathwater.

The torsion balance is designed to eliminate external interference. It's possible that along with the interference, they eliminated the actual gravity of the universe, which is needed to calculate the gravitational constant G. The acceleration caused by the mass of the universe was ignored because it isn't included in Newton's law and isn't registered by the instrument. The device for measuring G is designed to detect only the local gravitational force. Since Newton's law doesn't include the cosmological force of the Universe, physicists don't include it in the gauge equations.

The desire to isolate and record only the attraction of the masses and compensate for all external forces led to the cosmological force needed to calculate the gravitational constant G not being included in the calculations. The acceleration due to the mass of the Universe is either eliminated by filtering or simply ignored because it is not included in Newton's law.

On the one hand, the acceleration due to the mass of the Universe was ignored in all 17 measurements of G. It was treated as nonexistent. On the other hand, the influence of the acceleration due to the mass of the Universe could have been eliminated by filtering, along with the elimination of the influence of the Moon and the Sun. In both cases, a useful factor was lost. Throwing the baby out with the bathwater. And this "baby" is a component of the force that must be taken into account when calculating the gravitational constant G. This introduced a systematic error into all 17 measurements of G.

11. The formula F = GmM/r2 gives an approximate value of “big G”.

To understand the physical mystery surrounding attempts to accurately measure big G and why the best measurements still contradict each other, we must consider the limitations inherent in the Newtonian mathematical model of gravity. The gravitational constant G refers to the gravity of the entire Universe—this is its fundamental meaning. The measured value of G depends not only on technical limitations, but also on how adequately gravity is described by the physical law from which it is calculated.

It is problematic to obtain "big G" with high accuracy by relying on an idealized two-body gravitational law, which does not take into account the real gravity of all bodies in the Universe. It is also problematic to use setups that simulate the gravitational situation of only two bodies. All bodies participate in gravitational interactions. Therefore, the constant G must be calculated taking into account the gravitational interactions of all bodies. Instead of the formula $F = GmM/r^2$, it is proposed to use the formula $FU = GmM/r^2 + (mc^2)\sqrt{\Lambda}$.

Physicists are indeed in a paradoxical situation: they are trying to measure the global constant of the Universe, “big G,” within the framework of Newton’s law, which does not work on the scale of the Universe.

Since the device does not directly sense the gravitational force from the mass of the entire universe, and physicists do not factor it into their calibration equations, the formula $F = GmM/r^2$ yields an overestimated or underestimated value of G depending on the device's orientation in space. This overestimate or underestimate varies from laboratory to laboratory. It depends on the device's orientation in space, specifically, on the angle between the device's axes and the acceleration vector Ao. The magnitude of the overestimate or underestimate is determined not by the full vector, but by its projection onto the device's axes.

12. Observation of modulation (23 hours, 56 minutes, 4 seconds) in the TR&D-96 experiment.

Even if the instrument is perfectly isolated from noise on Earth, its rotation with the Earth will change its orientation relative to outer space, which can introduce additional noise. A sign that the additional noise is of cosmic origin is modulation not by solar time (24 hours), but by the sidereal day (23 hours, 56 minutes, 4 seconds). Stellar modulation of the signal means that the gravitational potential of the Universe is not the same in different directions. The instrument "scans" the sky as the Earth rotates, encountering a hidden cosmological vector—for example, the direction of the Great Attractor.

Such modulation was observed in the TR&D-96 experiment during repeat measurements in 2002 [30]. Peak values and extremes of fluctuations were observed when the axis between the test masses in the laboratory was aligned with the maximum concentration of outer cosmic mass—that is, along the center of the Milky Way (the direction of the constellation Sagittarius) and the plane of the galactic equator. The key astronomical connection is that the Great Attractor, for an observer on Earth, is located in almost the same direction as the center of the Milky Way.

Instead of using the detected modulation to refine the constant, the researchers concluded that the stellar cycle influences the spatial anisotropy of the gravitational constant [30]. Their claim was refuted by metrologists in [31]. However, the fact of observing modulation along the stellar day and using it to refine the constant requires closer examination.

13. Solving the inverse mathematical problem for extracting an external unaccounted factor from data arrays.

The main methodological problem can be identified: we are attempting to measure the fundamental constant of the Universe using Newton's equation, which does not take into account the Universe's gravity. As a result, we are isolating the laboratory from the Universe itself. If the Universe's influence were simple and uniform, all laboratories in the world would obtain the same biased but stable value of G. However, experiments performed in different countries and at different times yield different values.

Since laboratories in the United States (for example, NIST in Gaithersburg), China (HUST in Wuhan), and France (BIPM in Sèvres) are located at different latitudes and longitudes, their measurement axes are oriented at completely different angles to the "universe vector" at any given moment. This may be the cause of the discrepancy in the values of the constant G. The discrepancy in the measurement results isn't due to "dirty instruments," but rather a mathematical consequence of the formula not including the contribution of acceleration caused by the surrounding universe, mistakenly assuming that free fall has completely eliminated its influence.

When physicists say "the instrument is blind," they use this as an excuse to continue using Newton's formula as is, attributing the difference in results to poor suspension threads or terrestrial noise. But if physical reality is broader than the Newtonian model, then this "blindness" must be overcome not technically, but mathematically—by changing the calculation formula itself.

An inverse problem can help extract the external, unaccounted factor from data arrays: calculate under what conditions (depending on the trajectory of the torsion balance's spatial position relative to the "universe vector") all 17 values (or most of the values) of the constant converge at a single point. This can be done using raw, unprocessed force (or angular displacement) measurements from all 17 experiments. Calculate the precise trajectory of a specific laboratory, for example, relative to the Great Attractor and the cosmic microwave background, taking into account the Earth's rotation, tilt, and orbital velocity. Calculate corrections for the modified equation. Find the parameters of the cosmic vector at which the data from most laboratories converge at a single point.

14. Metrological Dead End or Metrological Triumph?

When ultra-precise instruments in different laboratories around the world consistently produce inconsistent yet perfectly reproducible results, this proves that metrology has accomplished its mission to the fullest. She ran into the limitations of the existing physical paradigm, not the imperfections of the instruments.

The stable discrepancy in Big G values, confirmed in 17 measurements, is a valuable experimental result for rethinking gravity. Over the years of gravity research, many "anomalies" have been discovered. Theoretical physics has been bogged down by conflicting hypotheses and has failed to provide a convincing explanation. Perhaps practical metrology can provide this. All gravitational anomalies share a common characteristic: they are all "anomalous" from the perspective of Newton's law. The Big G anomaly was also identified within the framework of Newton's law. Metrologists have uncovered a deep, systemic problem in our understanding of gravity. Metrology's contribution to gravity theory has been clearly demonstrated: it has been experimentally confirmed that the physical reality of gravity is broader than the Newtonian model of gravity.

Metrologists have honestly and accurately documented reality. And the fact that the measurement results diverge means the following: the instruments pointed to the reality that Newton's formula "does not see." This same Newtonian formula prompted metrologists to ignore the gravity of the Universe when measuring Big G, or to consider it extraneous noise.

To demonstrate that the metrological scatter of 17 values [32 - 49] is not chaos, it is necessary to solve the inverse problem and demonstrate that the convergence of all 17 results to a single point depends on the angles between the instrument's axis and the "vector of the Universe". This will prove that the experimenters of yesteryear were geniuses in precision measurements. They weren't wrong! The difference in their figures is a direct indication of the presence of an unaccounted physical factor. The experimenters obtained different figures because they conducted their experiments at different times and with different orientations of their institutes' buildings relative to space, and did not take into account either the gravity of the Universe or the orientation of the instruments in their calculations.

15. Gravitational Method for Measuring the Cosmological Constant Λ.

The new equation for the gravitational force $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$ (Fig. 1) contains two constants: "big G" and the cosmological constant Λ. This opens the possibility of not only solving the "big G" problem, but also, along the way, obtaining the value of the cosmological constant Λ. This consequence of the equation $F_U = GmM/r^2 + (mc^2)\sqrt{\Lambda}$ is especially valuable for modern experimental cosmology. Today, the cosmological constant Λ is one of the most imprecise quantities in fundamental physics. It is measured from fluctuations in the cosmic microwave background (the Planck mission) or from supernova explosions. The uncertainty in these astronomical measurements is enormous, amounting at best to a few percent (i.e., only two correct digits). The additional term $F_{Cos} = (mc^2)\sqrt{\Lambda}$ in the equation for calculating "big G" makes it possible to measure Λ using the gravitational method. Since the accuracy of force measurements in experiments with torsion balances and atomic interferometers exceeds 4–5 significant digits, we automatically extend the accuracy of the cosmological constant to the same level.

The discrepancies in the values of "big G" contain valuable information both for refining the value of G and for calculating the value of Λ. The real strength of gravitational interaction follows from the formula (Fig. 1) and falls in the range from $(GmM/r^2 - (mc^2)\sqrt{\Lambda})$ to $(GmM/r^2 + (mc^2)\sqrt{\Lambda})$. This corresponds to the range of obtained values of "big G" from 6.672… • 10^{-11} m^3 kg^{-1} s^{-2} to 6.675… • 10^{-11} m^3 kg^{-1} s^{-2}.

If we collect data on the value of G from all 17 experiments, taking into account the precise three-dimensional orientation of the instruments in space, geographic latitude, and time of year, then a system of equations can be derived from this data. By solving this system of equations, we can calculate the true, refined value of G and simultaneously the value of Λ with an accuracy astronomers never dreamed of.

The contribution of Λ to the gravitational force will vary in different laboratories depending on the projection of the cosmic vector onto the axis of a particular instrument. The main task will be to convert from projections to the full Ao vector. The cosmological correction for "big G" (mc^2)√Λ) will be the initial equation for calculating Λ. This will resolve the main catastrophe of theoretical physics of the 21st century, known as the "cosmological constant problem." The fact is that quantum field theory calculations predict a value of Λ 120 orders of magnitude (!) greater than the measured value. This is the worst agreement between theory and practice in the history of science. The possibility of laboratory measurements of Λ with an accuracy of 4–5 decimal places is opening up. This is the path to transforming cosmology from an observational science to a rigorous laboratory science. We must begin with raw, unprocessed, existing archival data from various laboratories that have measured the gravitational constant.

The scatter of G values, once considered the shame of experimental physics, is being transformed into a valuable data set. Each "erroneous" result becomes a unique vector indicating the true value of two constants: "big G" and the cosmological constant Λ. To implement this idea in practice, it is necessary to correctly formulate a system of equations that takes into account that the Earth rotates in three-dimensional space and constantly changes its projection angle relative to the cosmic background.

16. Conclusion.

When a fundamental constant stubbornly "resists" refinement, this indicates that an unaccounted physical factor is interfering with the experiments. The discrepancy between the Big G measurement results obtained by different scientific groups is not a metrological dead end, but valuable experimental data for rethinking gravity. This is the true value of the discovered discrepancy between the Big G measurements. The discrepancy in the results is a consequence of the calculation of Big G from Newton's law, which does not take into account the gravity of the enormous mass of the Universe.

This forces us to look at the problem of the "Big G crisis" from a completely new perspective. The "blind spot" of the instruments to the gravity of the Universe and the hidden systematic error due to the unaccounted real acceleration (c^2)√Λ are the unaccounted factors that could have turned the measurement of "Big G" into the biggest dead end in the history of metrology.

The cosmological force of the Universe is not a fifth force; it is still gravity. It always exists, but Newton's law of two-body gravity does not detect the gravity of the entire Universe. A setup designed to measure the gravitational force of two bodies also does not detect the gravity of the entire Universe. The measured value of G directly depends on how well the physical law used to calculate it describes gravity.

Metrologists sought a technical cause: they checked the density of the spheres, looked for microcracks in the suspension threads, and shielded the magnetic fields. But if the physical model of gravity is incomplete, even a perfect instrument cannot produce an accurate result.

17. Final Remarks.

1. "Big G" is a constant of the Universe and a parameter of the Universe. It reflects the gravity of the entire Universe, not just the local interaction of two objects, so its exact value cannot be derived from Newton's law. The crux of the problem lies in a methodological error: scientists persistently attempt to calculate the fundamental constant of the Universe from a formula that initially ignores the Universe's gravity.

2. The accuracy of G stopped at 4–5 significant digits precisely because this is the limit to which the real world can still be somehow described by Newton's idealized formula. Attempts to squeeze a sixth or seventh digit out of this formula are mathematically meaningless, since Newton's mathematical model increasingly diverges from reality as we move to the sixth, seventh, eighth, and so on digits. A different formula for calculations is needed instead of Newton's formula.

3. To obtain the exact value of G, it must be calculated taking into account the acceleration Ao = (c^2)√Λ, generated by the mass of the Universe. The key to the 6th, 7th, and subsequent decimal places of accuracy of G lies in taking into account the fundamental cosmological acceleration Ao = (c^2)√Λ.

4. Adapting to Newton's formula resulted in "throwing the baby out with the bathwater." They eliminated something essential from the calculations: the influence of the projection of the cosmological acceleration of the Universe Ao = (c^2)√Λ, mistaking it for random instrumental noise, and, along with this, lost the accuracy of the constant G itself.

5. The spread of G values is caused by a key methodological error in modern physics: the use of Newton's idealized formula forces metrologists to ignore the most valuable data, mistaking the fundamental influence of the cosmological acceleration of the Universe A_0 for random instrumental or terrestrial noise. Therefore, the scatter of values is not an experimental error, but real physical experimental evidence that local gravity is inextricably linked with the gravity of the entire Universe, which Newton in the 17th century simply could not take into account.

6. Neglecting the gravitational influence of the Universe's enormous mass leads to systematic errors in all local experiments. Along with the noise, scientists filter out the actual gravitational background of the Universe, which is necessary for the correct calculation of the constant.

7. The impossibility of obtaining an exact value for "Big G" from Newton's law does not mean that Newton's law $F = GmM/r^2$ is incorrect. This physical law was originally formulated for a simplified model of two-body gravity, so it is approximate. The formula for Newton's law of universal gravitation itself is incomplete. Newton's law only captures a portion of the gravitational force acting on an object. It "doesn't see" the additional background gravitational force of the universe. From the approximate local law of gravity, only an approximate value for the constant G can be calculated.

8. The new law of gravity $FU = GmM/r^2 + (mc^2)\sqrt{\Lambda}$ shows that when measuring "Big G," it is necessary to take into account not only the Newtonian gravitational force, but also the additional background gravitational force of the Universe. Earthly instruments do not directly detect the

background gravitational force of the Universe, and its indirect influence was eliminated by filtering out interference and adjusting the experimental conditions to Newton's law.

9. The consistent discrepancies in the values of the gravitational constant (“Big G”) found in 17 experiments arise because standard local calculations ignore the background gravitational influence of the entire Universe.

10. The new equation $FU = GmM/r^2 + (mc^2)\sqrt{\Lambda}$ (Fig. 1) opens the possibility of not only solving the "big G" problem, but also of obtaining the value of the cosmological constant Λ with an accuracy close to that of the gravitational constant. This will allow us to solve the main catastrophe of theoretical physics of the 21st century, known as the "cosmological constant problem."

11. The discrepancies in the values of "big G" contain valuable information both for refining the value of G and for calculating the value of the cosmological constant Λ. The real strength of gravitational interaction follows from the formula (Fig. 1) and ranges from $(GmM/r^2 - (mc^2)\sqrt{\Lambda})$ to $(GmM/r^2 + (mc^2)\sqrt{\Lambda})$. This corresponds to the range of obtained values of "big G" from $6.672 \cdot 10^{-11}$ $m^3\ kg^{-1}\ s^{-2}$ to $6.675 \cdot 10^{-11}$ $m^3\ kg^{-1}\ s^{-2}$.

12. The discrepancies in the values of the constant G obtained by different scientific groups are not a metrological dead end, but a reason to rethink gravity. All scientific groups confirmed with the highest accuracy the stable discrepancies in the measured values of the constant G. This is an extremely important scientific result. It is experimental confirmation of a systemic problem in our understanding of gravity. For science, this fact is even more significant than one or two additional digits in the value of the constant G. Reaching the sixth or seventh digit in G using Newton's formula would only give metrologists the illusion of control over the constant G. It would simply be a beautiful number in an incomplete model of gravity.

References.

1. Schlamminger, S. , Chao, L. , Lee, V. , Shakarji, C. , Newell, D. , Stirling, J. , Cochrane, R. and Speake, C. (2026), Redetermination of the Gravitational Constant with the BIPM torsion balance at NIST, Metrologia, [online], https://doi.org/10.1088/1681-7575/ae570f, https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=961075

2. Milgrom, M. A modification of the Newtonian dynamics - Implications for galaxies.Astrophysical Journal, Vol. 270, p. 371-383 (1983). DOI: 10.1086/161131 Page 9

3. U. Le Verrier (1859), (in French), "Lettre de M. Le Verrier à M. Faye sur la théorie de Mercure et sur le mouvement du périhélie de cette planète", Comptes rendus hebdomadaires des séances de l'Académie des sciences (Paris), vol. 49 (1859), pp. 379–383. https://en.wikipedia.org/wiki/Urbain_Le_Verrier

4. Pavel Kroupa, Tereza Jerabkova, Ingo Thies, Jan Pflamm-Altenburg, Benoit Famaey, Henri M J Boffin, Jörg Dabringhausen, Giacomo Beccari, Timo Prusti, Christian Boily, et al. Asymmetrical tidal tails of open star clusters: stars crossing their cluster’s práh challenge Newtonian gravitation. Monthly Notices of the Royal Astronomical Society, Volume 517, Issue 3, December 2022, Pages 3613–3639, https://doi.org/10.1093/mnras/stac2563

5. Kroupa, P., et al. (2023) The Many Tensions with Dark-Matter Based Models and Implications on the Nature of the Universe. https://arxiv.org/abs/2309.11552 https://doi.org/10.22323/1.436.0231

6. X. Hernandez, Pavel Kroupa. A recent confirmation of the wide binary gravitational anomaly. arXiv:2410.17178 [astro-ph.GA].

7. Newcomb S. The elements of the four inner planets and the fundamental constants of astronomy. Suppl. am. Ephem. naut. Aim. 1897. U.S. Govt. Printing Office, Washington, D. C., 1895.

8. Rubin, Vera; Thonnard, N.; Ford, Jr., W. K. (1980). "Rotational Properties of 21 SC Galaxies With a Large Range of Luminosities and Radii, From NGC 4605 (R=4kpc) to UGC 2885 (R=122kpc)". The Astrophysical Journal. 238: 471ff. doi:10.1086/158003 11.

9. Kosinov, M. (2026). HOW NEWTON’S LAW (THE LAW OF TWO-BODY GRAVITATION) BECAME CALLED THE LAW OF UNIVERSAL GRAVITATION. Cambridge Open Engage. doi:10.33774/coe-2026-2wvfk-v5

10. U. Le Verrier (1859), "Théorie du mouvement de Mercure" (Annales de l'Observatoire Impérial de Paris, 1859, Vol. 5, pp. 1–196).

11. Fritz Zwicky. On the Masses of Nebulae and of Clusters of Nebulae. The Astrophysical Journal (Vol. 86, pp. 217–246).

12. Kelvin, W. T. (1904). Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light. London: C. J. Clay and Sons. Appendix H. «On Clustering of Gravitational Matter in any Part of the Universe».

13. H. Poincare. (1906). The Milky Way and the Theory of Gases. Popular Astronomy. (Vol. 14, pp. 475–481).

14. Erwin Schrödinger. (1925). Über das Trägheitsmoment der Welt. Physikalische Zeitschrift, Nummer: 26

15. A. E. H. Bleksley. A new approach to cosmology: Iii. South African Journal of Science, 48 (1), 1951. URL https://hdl.handle.net/10520/AJA00382353_3467

16. Milne, E. A. On the foundations of dynamics. Proc. R. Soc. A 1936, 154, 22–52.

17. Stewart J. O. “Phys. Rev.”, 1931, v. 38, p. 2071.

18. Muradyan, R. M. Universal constants. Physical and astrophysical constants and their dimensional and dimensionless combinations. Fiz. ehlementar. chastits i atom. yadra, Vol. 8, No. 1, p. 175 - 192. 1977.

19. Dirac, P. A. M., Nature, 139, 323 (1937).

20. Dirac, P. A. M., Proc. R. Soc., A 165, 199 (1938)

21. S. Weinberg, “Gravitation and Cosmology,” Wiley, New York, 1972.

22. E. Teller, Phys. Rev. 73, 801(1948) E. Teller (1948). On the change of physical constants. Physical Review, vol.73 pp. 801—802. DOI:10.1103/PhysRev.73.801

23. Rice J. On Eddington's natural unit of the field // Philosophical Magazine Series 6. — 1925. — Vol. 49. — P. 1056—1057.

24. Kosinov, M. (2026). THREE THEOREMS FROM WHICH FOLLOW TWO NEW LAWS OF GRAVITATION AND A NEW LAW OF UNIVERSAL GRAVITATION. Cambridge Open Engage. doi:10.33774/coe-2026-g8kvq-v2

25. Kosinov, M. (2026). WHAT’S WRONG WITH THE LAW OF UNIVERSAL GRAVITATION? What should this law actually look like? Cambridge Open Engage. doi:10.33774/coe-2025-p2tdb-v7

26. Kosinov, M. (2025). PARADOXES OF GRAVITY: Newton’s Law Does Not Work at Large Distances, but... it’s too early to throw it in the scrapheap. . Cambridge Open Engage. doi:10.33774/coe-2024-6fr81-v2

27. Kosinov, M. (2026). NEW LAW OF UNIVERSAL GRAVITATION WITHOUT CONSTANT G. Cambridge Open Engage. doi:10.33774/coe-2025-tcjtj-v10

28. Kosinov, M. (2025). INVERSE N-BODY PROBLEM - THE KEY TO SOLVING GRAVITY PROBLEMS. Cambridge Open Engage. doi:10.33774/coe-2025-7w4k7-v4).

29. Dressler, Alan; Faber, S. M.; Burstein, David; Davies, Roger L.; Lynden-Bell, Donald; Terlevich, R. J.; Wegner, Gary. Spectroscopy and photometry of elliptical galaxies — A large-scale streaming motion in the local universe // Astrophysical Journal, Part 2 — Letters to the Editor. — 1987. — T. 313 (15 February). — C. L37—L42. — doi:10.1086/184827

30. Experimental evidence that the gravitational constant varies with orientation. by Mikhail L. Gershteyn, Lev I. Gershteyn, Arkady Gershteyn, Oleg V. Karagioz. arXiv:physics/0202058.

31. C. S. Unnikrishnan, G. T. Gillies. Nano-constraints on the spatial anisotropy of the Gravitational Constant. Physics Letters A. Volume 305, Issues 1–2, 25 November 2002, Pages 26-30. Phys. Lett. A305 (2002) 26-30. https://doi.org/10.1016/S0375-9601%2802%2901390-7

32. Luther G G and Towler W R 1982 Redetermination of the Newtonian gravitational constant g Phys. Rev. Lett. 48 121

33. Karagioz O V and Izmailov V P 1996 Measurement of the gravitational constant with a torsion balance Meas. Tech. 39 979

34. Gundlach J H and Merkowitz S M 2000 Measurement of Newton’s constant using a torsion balance with angular acceleration feedback Phys. Rev. Lett. 85 2869–72

35. Quinn T J, Speake C C, Richman S J, Davis R S and Picard A 2001 A new determination of G using two methods Phys. Rev. Lett. 87 111101

36. Quinn T J, Speake C, Parks H and Davis R 2014 The BIPM measurements of the Newtonian constant of gravitation, G Phil. Trans. R. Soc. A 372 20140032

37. Bagley C H and Luther G G 1997 Preliminary results of a determination of the Newtonian constant of gravitation: a test of the kuroda hypothesis Phys. Rev. Lett. 78 3047

38. Kleinevoß U 2002 Bestimmung der newtonschen gravitationskonstanten G PhD Thesis (University of Wuppertal)

39. Armstrong T R and Fitzgerald M P 2003 New measurements of g using the measurement standards laboratory torsion balance Phys. Rev. Lett. 91 201101

40. Luo J, Hu Z-K, Fu X-H, Fan S-H and Tang M-X 1998 Determination of the Newtonian gravitational constant G with a nonlinear fitting method Phys. Rev. D 59 042001

41. Hu Z-K, Guo J-Q and Luo J 2005 Correction of source mass effects in the HUST-99 measurement of G Phys. Rev. D 71 127505

42. Schlamminger S, Holzschuh E, Kündig W, Nolting F, Pixley R E, Schurr J and Straumann U 2006 Measurement of Newton’s gravitational constant Phys. Rev. D 74 082001

43. Luo J, Liu Q, Tu L-C, Shao C-G, Liu L-X, Yang S-Q, Li Q and Zhang Y-T 2009 Determination of the Newtonian gravitational constant G with time-of-swing method Phys. Rev. Lett. 102 240801

44. Tu L-C, Li Q, Wang Q-L, Shao C-G, Yang S-Q, Liu L-X, Liu Q and Luo J 2010 New determination of the gravitational constant G with time-of-swing method Phys. Rev. D 82 022001

45. Parks H V and Faller J E 2010 Simple pendulum determination of the gravitational constant Phys. Rev. Lett. 105 110801

46. Parks H V and Faller J E 2014 A simple pendulum laser interferometer for determining the gravitational constant Phil. Trans. R. Soc. A 372 20140024

47. Rosi G, Sorrentino F, Cacciapuoti L, Prevedelli M and Tino G M 2014 Precision measurement of the Newtonian gravitational constant using cold atoms Nature 510 518

48. Newman R, Bantel M, Berg E and Cross W 2014 A measurement of G with a cryogenic torsion pendulum Phil. Trans. R. Soc. A 372 20140025
49. Li Q et al 2018 Measurements of the gravitational constant using two independent methods Nature 560 582–8