Why Modern Physicists Do Not Understand Newtonian Gravity

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Abstract

In this paper we uncover the true power of Newton's theory of gravity. Did you know that hidden inside Newton's gravity theory is the speed of gravity, namely c? Physicists who claim that Newton's gravitational force is instantaneous have not yet understood Newton's gravity theory to its full extent. Did you know that the Newton's theory of gravity, at a deeper level, is actually a theory of quantum gravity? Did you know that what is central for gravity is the Planck length and not the gravitational constant? To truly understand Newtonian gravity, we have to understand that Newton's gravitational constant is actually a composite constant. Once we understand this, we will truly begin to understand what Newton's theory of universal gravitation is all about.

Key words: Newtonian gravity, gravitational constant, Planck constant, speed of gravity, quantum gravity.

1 Introduction

In this paper, we will look at several key concepts around Newtonian and Einsteinian gravity. In a series of recent papers [1, 2, 3, 4], Haug has suggested that Newton's gravitational constant, big G, is a composite constant of the form $G = \frac{l_p^2 c^3}{\hbar}$ and that the Planck length and the speed of light are the true fundamental constants. Certainly we will not forget the Planck constant either, even though the last of these three constants is a different story all together.

A fundamental constant should ideally be linked directly to something that we logically can understand. The Planck length, for example, is simply a very short length – the shortest length that it is possible to measure indirectly with no knowledge of the gravitational constant; see [3]. The constant for the speed of light represents how far light moves during a given time interval. Here we will show that what is really important is that Newton's gravitational constant contains the Planck length. Therefore, as we will see, anything that has been measured in relation to gravity so far has to do with the Planck length as well.

McCulloch 2013 [5] has derived a similar formula for big G based on Heisenberg's uncertainty principle. Haug [1] has also derived this formula from dimensional analysis and from Heisenberg's uncertainty principle, using his newly-introduced maximum velocity formula for matter [6].

The new way to understand the gravitational constant and Newton's formula implies that Newton's theory of gravitation is Planck-quantized. And not only that; it also contains (embedded) the speed of gravity, which turns out to be the same as the speed of light. We do not suggest that Newton realized this himself. It is all hidden in his gravitational constant, which (without deeper knowledge) is simply a constant calibrated to observations in order to make the theory of universal gravitation work. However, the universe did not simply invent a constant. Further, Newton's gravitational constant is in the form $m^3 \cdot kg^{-1} \cdot s^{-2}$ – it seems unlikely that anything intended to be meaningful at a deeper level should be meters cubed divided by kg and seconds squared. This alone strongly indicates that it is a composite constant.

Once we have discovered the deeper composite structure of the Newton constant, then both Newton's gravitational theory and Einstein's gravitational theory truly begin to open up for us.

In the next sections, we will look at modern physics assumptions about Newton's theory that simply do not make sense when examined closely; we find that the mainstream views often lack a true understanding of the gravitational constant.

Shock 1: The Planck Length Is What Is Essential for Any Gravity Measurements, Not Big G,

The best-known Newtonian [13] gravitational formula is given by

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$$F = G\frac{Mm}{r^2} \tag{1}$$

we have written M and m on purpose here, and they actually only hold when we have a mass much larger than the second mass. Let us now write the gravitational constant in the composite form, $G = \frac{l_p^2 c^3}{\hbar}$, as suggested by Haug. In addition, we will describe the masses in terms of the number of Planck masses

$$F = G\frac{Mm}{r^2} = \frac{l_p^2 c^3}{\hbar}\frac{n_1 \frac{\hbar}{l_p}\frac{1}{c} n_2 \frac{\hbar}{l_p}\frac{1}{c}}{r^2} = n_1 n_2 \frac{\hbar c}{r^2} \tag{2}$$

where n_1 and n_2 simply are the number of Planck masses in the large and small mass, $M = n_1 m_p$ and $m = n_2 m_p$. Bear in mind that the Planck mass is given by $m_p = \frac{\hbar}{l_p}\frac{1}{c}$.

From this we can see than in Newton's gravitational force formula, the Planck length squared for any mass larger than the Planck mass will cancel out. There is no Planck length in the formula itself. Thus, one could mistakenly conclude that Newtonian gravity is not dependent on the Planck length. This would be a grave mistake, as no one has never observed Newton's gravity force directly. All observations in gravity correspond to aspects of gravity where we need to manipulate the Newton gravity formula and get rid of one mass – then one of the Planck lengths will no longer cancel out. We think this is an important key to understanding gravity at a deeper level. Gravity, despite being observed as an effect between macroscopic objects, is actually much about the Planck length. In Table 1 we have listed a series of formulas related to Newtonian gravity that we can observe, and also note Newton's gravitational force itself, which we cannot observe.

What we can observe:	**Standard form**	**Deeper form:**
Cavendish angle	$\theta = \sqrt{\frac{GMT^2}{2\pi L r^2}}$	$\theta = c\sqrt{\frac{l_p n T^2}{2\pi L r^2}}$.
Orbital velocity	$v_o = \sqrt{\frac{GM}{r}}$	$v_o = c\sqrt{n\frac{l_p}{r}}$
Gravitational acceleration field	$g = \frac{GM}{r^2}$	$g = n\frac{l_p}{r^2}c^2$
Gravitational red-shift	$\lim_{r\to+\infty} z(r) = 2\frac{GM}{c^2 r}$	$\lim_{r\to+\infty} z(r) = n2\frac{l_p}{r}$.
Gravitational deflection	$\delta = 4\frac{GM}{c^2 r}$	$\delta = n4\frac{l_p}{r}$.
Gravitational time dilation	$t_0 = t_f\sqrt{1 - \frac{\frac{2GM}{c^2}}{c^2}}$	$t_0 = t_f\sqrt{1 - n\frac{2l_p}{r}}$
What we cannot observe:	**Standard form**	**Deeper form:**
Gravitational force	$F = G\frac{Mm}{r^2}$	$F = n_1 n_2 \frac{\hbar c}{r^2}$

Table 1: The table of a series of measurements that can be observed and measured in relation to gravity, and the gravitational force that we cannot observe or measure.

The key point here is that in all of the formulas linked to gravitational aspects, we can observe that we only have GM, rather than GMm. This is more important than it may seem at first; when the gravitational constant only is multiplied with one mass rather than two masses, then we are always left with the Planck length – the Planck lengths do not cancel out. Orbital speed, gravitational acceleration, gravitational deflection, and gravitational time dilation are all dependent on the Planck length. The Planck length is essential for gravity.

In this view, big G is mainly important in gravity because it contains the Planck length squared, and because in all observational phenomena around gravity, the Planck lengths do not cancel out. The Planck length is, in every gravity formula, related to things we can observe in gravity, but not in any other formulas known to physics, except for the maximum velocity of matter, as recently discussed by Haug [1, 3, 7, 9, 10, 12].

McCulloch [5] has, in a very interesting paper, derived Newton's gravitational formula from Heisenberg's uncertainty principle utilizing Planck masses. Based on the insight presented here, this makes good sense. In gravitational observational research, even if we typically are working with macroscopic objects, we see that all observable gravitational phenomena are dependent on the Planck length, as shown in our analysis here. This indicates that McCulloch's view is not only valid, but that his derivation reveals something deeper. Could we finally be on the edge of understanding the link between the quantum world and the force of gravity?

Further, we can easily introduce the gravitational constant in areas of physics where it has not been used before and we will still get the correct output and predictions. For example, the Rydberg constant is normally given as

$$R_\infty = \frac{m_e e^4}{8\epsilon_0^2 h^3 c} = \frac{\alpha^2}{4\pi\lambda_e} \approx 10973731.58 \tag{3}$$

where α is the fine structure constant. However, the Rydberg constant can easily be re-written as a function of big G (as likely first shown here)

$$R_\infty = \frac{1}{2}\frac{Gm_pm_e}{hcl_p}\alpha^2 = \frac{Gm_e}{4\pi l_p^2}\frac{\alpha^2}{c^2} \approx 10973731.58 \tag{4}$$

So, does this mean the gravitational constant and gravity play a role in the Rydberg constant? No, but what is important is that we have l_p^2 in the same formula as big G. The Planck length in the denominator will cancel out the embedded Planck length squared that is hidden inside big G. Big G is simply a composite constant, but it is also more, because it contains the Planck length, which does not get canceled out in any calculation related to what we find in gravitational observations. Decomposed as much as possible, the Rydberg constant is (as well-known)

$$\begin{aligned} R_\infty &= \frac{Gm_e}{4\pi l_p^2}\frac{\alpha^2}{c^2} \\ R_\infty &= \frac{\frac{l_p^2c^3}{\hbar}\frac{\hbar}{\lambda_e}\frac{1}{c}}{4\pi l_p^2}\frac{\alpha^2}{c^2} \\ R_\infty &= \frac{\alpha^2}{4\pi\lambda_e} \approx 10973731.58 \end{aligned} \tag{5}$$

That is to say that the Rydberg constant is not a function of the Planck length, nor of Planck's constant, or the speed of light, in other words big G is not needed to calculate the Rydberg constant, even if we can use it. Only in calculations where we need the Planck length, and the speed of light, and to some degree Planck's constant, will we have truly need for big G. Big G was introduced because until very recently we did not understand that the Planck length and the speed of light (gravity) are the most essential measures for understanding gravity. Thus, the Planck length, the speed of light, and Planck's constant are the truly essential constants. And even then, we maintain that Planck's constant is not as important as the other two; see [11].

Further, Haug [3] has recently shown that one can extract the Planck length directly from a Cavendish experiment without any knowledge of big G at all.

Shock 2: Embedded in Newton's Theory of Gravity Is the Speed of Gravity

A myth, rather than a fact, among many physicists seems to be that Newton's theory of gravity predicts non-locality. Several physicists claim that Newton's gravity theory predicts that a change in the mass distribution will instantaneously affect the rest of the universe, and that Einstein had to address this and he introduced gravity that moved at the speed of light. For example, theoretical physicist Professor Jean Bricmont [14] claims in his wonderful book that Newtonian gravity is instantaneous, or in his own words

> *This makes actions at distance possible since the gravitational force depends on the distribution of matter in the Universe, changing the distribution, say by waving my arm, instantaneously affects the motion of all other bodies in the universe.*

In his 1704 book Opticks [15], Newton, based on Rømer's findings, calculated that it would take seven to eight minutes for light to travel from the Sun to the Earth. However, Newton did not link the speed of light to the speed of gravity; on the contrary, he seems to have believed that gravity was an instantaneous force. Still, the speed of light (gravity) is hidden in his gravitational formula.

We do not claim Newton knew that the gravitational formula embedded in the gravitational constant contained the speed of light. Newton was actually not able to measure the gravitational constant in his formula, and he did not know that such measurements are indirectly dependent on the speed of light, as well as on the Planck length, and the Planck constant. Newton's gravitational constant was first measured indirectly, but quite accurately, in 1798 by Cavendish [8], who was also unaware that it was a composite constant.

Some statements by Newton seem to have created this myth that the Newtonian force is instantaneous. Further, as we have said, the speed of light does not appear directly in Newton's formula, but is instead hidden inside big G. We would maintain that professors in theoretical physics might revisit this issue and dig more deeply into the nature of big G.

Shock 3: Newton's Theory of Gravity Is a Theory of Quantum Gravity

My next claim is that the Newtonian theory of gravity is, at a deeper level, a theory of quantum gravity. Again, the key lies in understanding that Newton's gravitational constant is a composite constant of the form $G = \frac{l_p^2c^3}{\hbar}$.

We have already seen that the Planck length enters into every gravity formula that corresponds to something we can observe in experiments.

We predict that n in the formulas in Table 1 can only be integers. However, the fact that Newton's gravity theory is a quantum gravity theory in this perspective does not mean it is correct at the subatomic level. In the next section we will speculate on how the Newtonian theory could be modified for the subatomic scale. Clearly we have not developed a full and final theory of quantum gravity either; our speculations in the appendix could be wrong and more research is needed.

Speculations about Possible Adjustments to Newton's Gravitational Constant

One speculative idea would be to modify the gravitational constant when we are working with masses of a size smaller than a Planck mass. As long as we work with masses larger or equal to the Planck mass, then we have the standard value of the gravitational constant

$$G = \frac{l_p^2 c^3}{\hbar} \approx 6.67 \times 10^{-11} \tag{6}$$

The suggested modification would be to make an adjustment when we work with gravity for masses smaller than the Planck mass:

$$G_m = \frac{\bar{\lambda}_1 \bar{\lambda}_2 c^3}{\hbar} \tag{7}$$

In this speculative theory, only when the two masses of interest are larger or equal than the Planck mass would we have $\bar{\lambda}_1 = l_p$ and $\bar{\lambda}_2 = l_p$. For example, in the case of a proton and an electron we would have $\bar{\lambda}_1 = \bar{\lambda}_P$ and $\bar{\lambda}_1 = \bar{\lambda}_e$. This would mean that the modified gravity theory would predict a much stronger gravity for any observed subatomic particle than it does today. One of the mysteries in modern physics is why the electromagnetic force is so much stronger than the gravity force. (Actually, this is only partly true: for the Planck mass particle, the gravity and Coulomb forces [16] are the same.) The Coulomb force between two elementary charges existing at a distance equal to the proton's reduced Compton wavelength apart is

$$F = k_e \frac{ee}{\bar{\lambda}_P^2} \approx 5216.110083 \tag{8}$$

The standard gravity force between two protons that exist a proton Compton wavelength apart is only

$$F = G \frac{m_P m_P}{\bar{\lambda}_P^2} \approx 4.22139 \times 10^{-33} \tag{9}$$

or between a proton and an electron

$$F = G \frac{m_P m_e}{\bar{\lambda}_P^2} \approx 2.29904 \times 10^{-36} \tag{10}$$

Again, we see the gravity force is incredibly low compared to the electromagnetic force, but let's now use our modified gravity constant, since the two masses are below the Planck mass size. Then we have

$$F = G_m \frac{m_P m_P}{\bar{\lambda}_P^2} = \frac{\bar{\lambda}_P \bar{\lambda}_P c^3}{\hbar} \frac{m_P m_P}{\bar{\lambda}_P^2} \approx 714794.9058 \tag{11}$$

Interestingly (but not surprisingly by looking at the formulas) the gravity force is now exactly 137.0360085 times as strong as the electrostatic force. The difference between the gravity force and the electrostatic force is, in this view, only the fine structure constant. What the fine structure content truly represents and why it has the value it does we do not have the answer to yet. Or as said by Feynman

> *It has been a mystery ever since it was discovered more than fifty years ago, and all good theoretical physicists put this number up on their wall and worry about it.* – Richard Feynman

This modification of big G would also lead to a modification of Einstein's field equation [17] when working with subatomic particles with a mass smaller than the Planck mass. Einstein's field equation is given by

$$R_{\mu v} - \frac{1}{2} g_{\mu v} R = \frac{8\pi G}{c^4} T_{\mu v} \tag{12}$$

This can be written as

$$
\begin{aligned}
R_{\mu v}-\frac{1}{2}g_{\mu v}R &= \frac{8\pi\frac{l_p^2c^3}{\hbar}}{c^4}T_{\mu v}\\
R_{\mu v}-\frac{1}{2}g_{\mu v}R &= \frac{8\pi l_p^2}{c\hbar}T_{\mu v}
\end{aligned}
\tag{13}
$$

Using the alternative speculative G_m when we are working with masses smaller than the Planck mass would give

$$
\begin{aligned}
R_{\mu v}-\frac{1}{2}g_{\mu v}R &= \frac{8\pi G_m}{c^4}T_{\mu v}\\
R_{\mu v}-\frac{1}{2}g_{\mu v}R &= \frac{8\pi\frac{\bar{\lambda}_1\bar{\lambda}_2c^3}{\hbar}}{c^4}T_{\mu v}\\
R_{\mu v}-\frac{1}{2}g_{\mu v}R &= \frac{8\pi\bar{\lambda}_1\bar{\lambda}_2}{\hbar c}T_{\mu v}
\end{aligned}
\tag{14}
$$

This would mean a much stronger gravity than General Relativity predicts when we are working with masses smaller than the Planck mass, and the same gravity as we find under GR when we are working with masses larger or equal to the Planck mass. For example, the gravitational force between an electron and a proton would now be approximately $\frac{G_m}{G}=\frac{\bar{\lambda}_P\bar{\lambda}_e}{l_p^2}\approx 3.1091\times10^{41}$ times the gravitational force that would otherwise be predicted today. Between two protons we would get a gravitational force of about $\frac{G_m}{G}=\frac{\bar{\lambda}_P\bar{\lambda}_P}{l_p^2}\approx 1.69\times10^{38}$ times the force that would be predicted in the conventional gravity formula today. Is it merely a coincidence that the strong force is assumed to be approximately 10^{38} times the gravitational force for such subatomic particles[1]? Does this speculative modification lead to something significant? Those who seek a unified theory are, after all, attempting to find a framework that unifies all forces. Lee Smolin has written a book that assesses, at a basic level, "Three ways to quantum gravity", [18]. Perhaps there is a fourth way that starts with the understanding that Newton's gravitational constant is a composite constant. And, as we have speculated here, it may need to be modified when we are working with masses smaller than a Planck mass.

Even if this speculation about a modified gravitational constant in this instance should be totally wrong, it does not contradict the notion that Newtonian gravity theory, when understood at a deeper level, is actually a quantum gravity theory.

Conclusion

There is overwhelming evidence, based on logic and calculations, that the gravitational constant is a composite constant. Understanding this is essential for truly understanding Newton's theory of universal gravitation. In our view, embedded in Newton's theory is the speed of gravity, which is equal to the speed of light, and Planck quantization. We have also shown that any observable gravity phenomena are dependent on the Planck length.

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