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Planck Values by Cycle

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1. Introduction

In this paper, two complementary formulas for the Planck mass and the Planck length are presented, which provide higher accuracy compared to the values reported in CODATA reports. Therefore, we first present the input data used [1]. The formulas are proton-oriented and are analyzed on the basis of data from CODATA reports for the period 1986–2022.

Table 1 – Input CODATA data

year	m_p (×10⁻²⁷ kg)	$\mu = m_p / m_{el}$	Inverse α	$\bar{\lambda}_p$ (×10⁻¹⁶ m)
1986	1.67262310	1836.152701	137.0359895	2.10308937
1998	1.672621587	1836.1526675	137.035999760	2.103089090
2002	1.672621710	1836.1526726	137.03599911	2.1030891035
2006	1.672621637	1836.15267247	137.035999679	2.1030890862
2010	1.672621777	1836.15267245	137.035999084	2.10308910469
2014	1.672621898	1836.15267389	137.035999139	2.10308910108
2018	1.67262192369	1836.152673430	137.035999084	2.10308910336
2022	1.67262192595	1836.152673426	137.035999177	2.10308910050

All values are based on the CODATA adjustment and are given in SI units.

The significance of this work lies in demonstrating the validity of the two assumptions presented in [2], which are related to the proton and the mathematical constant $e^{2\pi}$. here adapted in the exponent of the formulas:

2. Formulas

The formulas are:

$$m_{pl} = m_p * (2\pi)^{-3/4} * 2^{\mathrm{cy}/8 - 3/2 + 3/(4\alpha\mu+8)} \tag{1}$$

$$l_{pl} = \bar{\lambda}_p * (2\pi)^{3/4} * 2^{-(\mathrm{cy}/8 - 3/2 + 3/(4\alpha\mu+8))} \tag{2}$$

where $cy = e^{2\pi} = 535.491656$

is a mathematical constant, which we denote as *Cycle*, and the known physical constants are m_p, μ, α^{-1}, $ƛ_p$, listed in the header of Table 1.

Note:
In the given formulas, α is used, while in Table 1 its inverse value, α^{-1}, is reported. All formulas require the same constant value $cy = e^{2\pi}$.

The aim of this paper is to analyze the performance of the proposed formulas, whereas a detailed explanation of their derivation would go beyond its primary purpose and would largely constitute a repetition of considerations already presented in a series of previous works on this platform (see, for example, [2, f 8 and 13]). In this sense, the present work provides another application of the same conceptual framework.

At the same time, the proposed formulas do not lose their significance even if they are regarded as heuristic or as numerical coincidences which, nevertheless, yield consistent results. The most convincing argument in favor of their relevance is that the formulas themselves speak for it.

Their complementarity becomes evident in the fact that the second and third terms have opposite signs and therefore cancel each other when multiplied, leaving the relation:

$$m_{pl} * l_{pl} = m_p * ƛ_p = \hbar / c \qquad (3a)$$

which represents another well-known form of the expression for $\hbar/c$.

Throughout the history of CODATA reports, these two formulas yield the following results, which are presented in Table 2 alongside the corresponding CODATA values.

Table 2 – CODATA values and results obtained from the formulas

godina	CODATA m_{pl} ($\times 10^{-8}$ kg)	Formula (1) m_{pl} ($\times 10^{-8}$ kg)	CODATA l_{pl} ($\times 10^{-35}$ m)	Formula (2) l_{pl} ($\times 10^{-35}$ m)
1986	2.176 71(14)	**2.176 5116**	1.616 05(10)	**1.616 198 977**
1998	2.176 71(16)	**2.176 5097**	1.616 0(12)	**1.616 198 761**
2002	2.176 45(16)	**2.176 5098**	1.616 24(12)	**1.616 198 772**
2006	2.176 44(11)	**2.176 5097**	1.6162 52(81)	**1.616 198 759**
2010	2.176 51(13)	**2.176 5099**	1.616 199(97)	**1.616 198 773**
2014	2.176 470(51)	**2.176 5101**	1.616 229(38)	**1.616 198 770**
2018	2.176 435(24)	**2.176 5101**	1.616 255(18)	**1.616 198 772**
2022	2.176 434(24)	**2.176 5101**	1.616 255(18)	**1.616 198 770**

Note: Values in parentheses represent the standard uncertainty in the last digits of the quoted value. Formula results are shown without uncertainty for clarity. All values are given in SI units.

The uncertainty of the results obtained with both formulas is approximately 5×10^{-12}, which is about five times smaller than the uncertainties reported in the CODATA reports.

3. Unified conclusion (Planck mass and Planck length)

The same pattern holds for both the Planck mass and the Planck length: formulas based on proton–related constants (**μ, α, m_p, λ_p**) produce numerically stable values over time, with significantly smaller uncertainty compared to historical CODATA measurements. This implies that, had this relation been known earlier, it would have enabled more precise estimates of the fundamental Planck scales than those available from measurements at the time, without introducing any additional empirical parameters.

In this sense, the obtained result does not appear to be a mere numerical coincidence, but rather a manifestation of a structural link between Planck-scale quantities and the proton scale, which becomes apparent only when the constants are considered in combination rather than in isolation.

In all CODATA editions up to 2014, the experimentally determined value of the Planck length exhibits a substantially larger uncertainty than the value obtained from the formula. The formula yields a stable central value with an almost constant standard uncertainty σ that is four to five times smaller. From 2010 onward, the CODATA central values practically converge toward the value obtained from the formula, albeit still with a larger experimental error.

4. Mirror symmetry of mass and length deviations

If the CODATA values of the Planck mass and the Planck length are examined over time, an almost mirror–symmetric behavior of their deviations relative to the values obtained from the formula can be observed:

- CODATA values of the Planck mass in earlier editions are systematically larger than the value obtained from the formula and gradually decrease toward it.
- At the same time, CODATA values of the Planck length are systematically smaller and gradually increase toward the value obtained from the formula.

This behavior is not accidental but mathematically expected. Its structural cause lies in the fact that the Planck quantities are related by the relation:

$$m_{pl} * l_{pl} = \sqrt{\hbar c / G} * \sqrt{\hbar G / \mathrm{c}^3} = \hbar / c \qquad \textbf{\textit{(3b)}}$$

which means that the relative error in the gravitational constant G enters:

- with a positive sign in m_{pl},
- with a negative sign in l_{pl}.

In other words, an increase in the estimated value of ***G*** leads to an increase in the Planck mass and a simultaneous decrease in the Planck length, while a decrease in ***G*** manifests itself through the opposite effect.

Equivalently:

$$\delta m_{pl} / m_{pl} = -\delta l_{pl} / l_{pl} = \delta G / 2G \qquad \textbf{(4)}$$

Therefore, every historical change in the estimated value of the gravitational constant automatically produces mirror deviations of mass and length. Let us note that the gravitational constant is unnecessary in this context and was not used by Newton; it was defined much later and merely named after him [3].

The particular value of the proposed formulas is reflected in the following points:

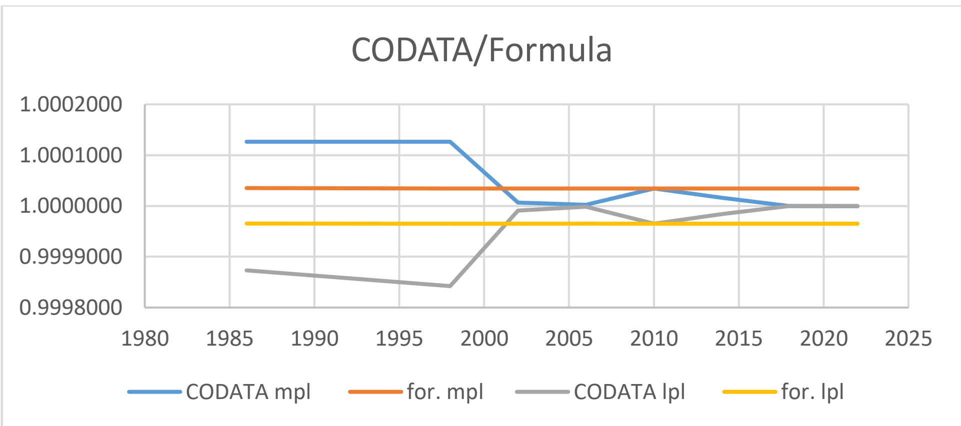
- they do not use the gravitational constant ***G*** as an input quantity,
- they rely exclusively on microphysical constants ($\boldsymbol{\mu, \alpha, m_p, \lambda_p}$),
- they simultaneously yield mutually consistent values of the Planck mass and the Planck length, without the need for any subsequent compensation.

The CODATA values of the Planck mass and the Planck length deviate in a complementary manner relative to the reference values obtained from the formula, precisely as a consequence of their common dependence on the gravitational constant. Their opposite deviations represent a mirror reflection of the same uncertainty in the estimation of ***G***, while the values obtained from the formula remain stable because they do not depend on ***G*** at all.

This effect is most clearly illustrated in the figure below. The graph is constructed by taking the CODATA value for the year 2018 as a reference, and then calculating for each year the ratios:

$$\boldsymbol{m_{pl} / m_{pl}(2018)} \qquad \text{and} \qquad \boldsymbol{l_{pl} / l_{pl}(2018)}$$

which allows a comparison of the behavior of the mass and length parameters throughout the CODATA history.



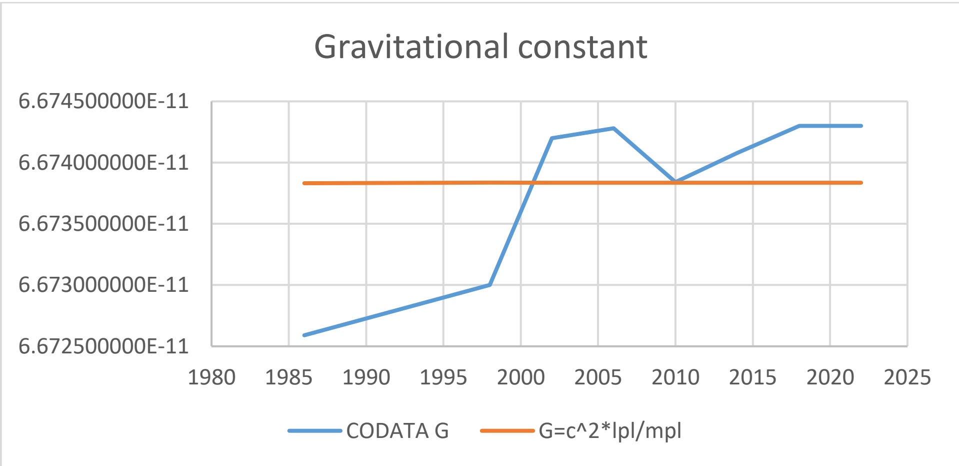
If, instead of the speed of light and Planck's constant, the proton mass and the proton wavelength were taken as exact, the theoretical uncertainty of the formula would be further reduced and limited exclusively by the precision of dimensionless constants, which would be more favorable than the SI definition of the Planck quantities based on the gravitational constant. In that case, the uncertainties would be on the order of $\sigma \approx 5\times10^{-14}$.

5. Gravitational constant

If the gravitational constant is expressed using the standard relation in terms of the Planck mass and Planck length,

$$G = c^2 * l_{pl}/m_{pl} \qquad (5)$$

and the values of these quantities obtained from the corresponding formulas are used, a comparative plot is obtained showing their values alongside the experimentally recommended CODATA values throughout their historical revisions.



The plot clearly indicates that theoretical knowledge of the relations for the Planck parameters would have provided significantly more accurate and internally consistent values of the gravitational constant in earlier periods than those obtained from experiments alone. This agreement further supports the validity and informational value of the proposed formulas.

6. Fundamental particle

There exists an infinite number of combinations of mass and distance values that satisfy condition ***(6)***:

$$m * r = \hbar / c \qquad (6)$$

The reduced Planck constant $\hbar$ is defined precisely by such a characteristic pair—the Planck mass (m_{pl}) and the Planck length (l_{pl}).

Another well–known example comes from nuclear physics, where, by convention, a particle of radius r_{nu} and the corresponding mass m_{nu} is used, chosen so as to satisfy condition ***(6)***:

$$m_{nu} = 3.517672941746*10^{-28}, \qquad r_{nu} = 1fm \qquad (7)$$

Instead of this adopted pair of values, we introduce a *fundamental particle* [4], whose mass m_f and radius r_f also lie in the interval between the proton and electron masses, as in case ***(7)***, but are at the same time related to the Planck parameters through the rational expressions ***(8)*** and ***(9)***:

$$m_f = (2\pi)^{-1/3} * 2^{-cy/9} * (m_{pl}/m_p)^{8/9} * m_p = 1.088621711 * 10^{-28}\ kg, \qquad (8)$$

$$r_f = (2\pi)^{1/3} * 2^{cy/9} * (m_{pl}/m_p)^{-8/9} * \lambda_p = 3.231308824 * 10^{-15}\ m \qquad (9)$$

The values of m_f and r_f, calculated using data from 2018, satisfy condition ***(6)*** as well as a number of additional criteria. For this reason, they prove to be more suitable for applications in nuclear physics than the standard choice given in ***(7)***.

7. Conclusion

The proposed formulas for calculating the Planck mass and the Planck length are proton-related and have demonstrated their significance as essential parameters of nature.

The analysis has revealed the causes of the large uncertainties of the Planck values in the CODATA reports.

Once again, this example confirms the usefulness of employing the mathematical constant ***cy*** (Cycle) and proton-oriented constants.

Also confirmed is the view of Espen Gaardner: *„Big G is not needed in physics; it has mainly caused confusion!“.*

Based on the foregoing considerations, a pair of mass and distance values (m_f, r_f) is proposed that is more suitable for use in nuclear physics than the conventional pair based on a separation of 1 femtometer.

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