

What Does the Exponent of c Count?

— The Exponent Formula of the Planck Reduction, ϵ as Mass Dimension, the Non-Uniqueness of 4π , and the $n = d - 1$ That Was Sitting in the Denominator — [Paper 116]

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— *From thinking to syncing.* —

Abstract

Paper 44 showed that under the Yamagishi patch $G = 4\pi$, $\hbar = \frac{1}{4\pi}$ every Planck quantity reduces to c^N or $\frac{c^N}{4\pi}$, and in the same breath imposed a self-limitation: **it does not assert as a theorem that the exponent of c , N , means a spatial dimension**. This paper converts that self-limitation **from an open rhetorical stance into a closed computation**. **First, the exponent formula is made explicit**: in d spatial dimensions, writing a quantity of dimension $[X] = L^\lambda M^\mu T^\tau$ as $X = \hbar^p G_d^q c^N$, and setting $n := d - 1$, one has $q = \frac{\lambda + \tau - \mu}{n}$, $p = \mu + q$, $N = -(\mu + \tau) - 3q$, and this solution is **unique** (the determinant of the linear system is $1 - d = -n$). **Second, the “3” in c^3 is not a spatial dimension**: it is the sum of what $\hbar$ carries, T^{-1} , and what G carries, T^{-2} , i.e. a **time weight**, and it does not depend on d . Indeed for every d one has $\ell_P = \left(\frac{\hbar G_d}{c^3}\right)^{1/n}$: the 3 never moves. **Third, where then is the dimension? In the denominator, as $n = d - 1$** . d enters N only through $1/n$, and that n is precisely the Gauss-law exponent ($n = 2$ of Paper 01; the $n = d - 1$ of Paper 114). **It was not where we went looking; it was sitting inside the square root**. **Fourth, the ϵ of Paper 44 is the mass dimension**: with $G = a$, $\hbar = 1/a$ one finds $X = a^{-\mu} c^N$, i.e. $\epsilon_X = \mu_X$, so the geometric/material dichotomy is nothing but $\mu = 0$ versus $\mu = 1$ (a **derivation** of Paper 44’s Theorem 3.1). **Fifth, 4π is not selected**: the closure holds for **every $a > 0$** . The one item that does fix a is the Planck charge — but the 4π there is the **SI rationalisation convention** put in by hand, and in Gaussian units the same requirement selects $a = 1$ instead. **A value whose “forcing” is a function of the unit convention is a convention, not a fact** (Paper 95). **Sixth, the reduction is not injective**: its kernel is the single ray spanned by $\hbar G$ (Paper 39), which is why density and power collapse onto the same c^5 in Paper 44’s table. **And what this formula gives is checkability**: any claim of the form “ N counts dimensions” can now be adjudicated by substitution. **The naive form is false** (at $d = 5$ the N of Planck power is $7/2$, and at $d = 6$ it is $16/5$; these cannot be dimension labels).

Scope of this paper (scope note): every piece of mathematics used here is **known and elementary** — dimensional analysis (Buckingham, Bridgman), the solution of a three-by-three linear system, and the standard higher-dimensional Planck length $\ell_P^{D-2} = \hbar G_D / c^3$ of the extra-dimension literature. No new theorem is proved and no prediction is made (Layer 2). The exponent formula is an identity inside dimensional analysis and **does not cross Wall I (the circularity)** — it gives no independent route to the value of N . **The claim that “ c is the building material of dimension” is neither supported nor refuted** (it stays at Layer 3, labelled non-scientific). No meaning is read into individual values of N (Papers 101 and 94). A resonance is a signature, not a proof (Paper 100). Relation to earlier papers: $n = d - 1$ comes from Papers 01 and 114, the cancellation $\hbar G = 1$ from Paper 39, the distinction between fact and convention from Paper 95, the configurations of convention from Papers 05 and 35, and the discipline of addresses from Paper 17. The numbers of Paper 44’s theorems, corollaries and items cited in the text are those of its second edition, against which this paper was written (in its third edition Paper 44 took in this paper’s $\epsilon = \mu$ and the audit of item (x), and put item (x) on hold). **What this paper adds** is (i) the explicit exponent formula, settling what N is a function of; (ii) the derivation of Paper 44’s ϵ as the mass dimension; (iii) the answer no to the uniqueness test for $a = 4\pi$; (iv) the audit of item (x) (charge) of Paper 44; (v) the identification of the kernel of the reduction — and the address that **the single place at which the spatial dimension touches the exponent of c is the denominator $n = d - 1$.**

1. Introduction: Turning a Dream into a Checkable Question

One conviction has walked alongside this series for a long time: **the speed of light c is the building material out of which dimension is made.** Paper 44 travelled furthest in that direction — and it is also the paper that stopped most honestly. Paper 44 wrote of itself (in its second edition):

“This paper does not assert as a theorem that the exponent of c , N , means the spatial dimension N .”

That self-limitation is correct. But it is **not sufficient**. “Does not assert” is a **posture**, not a **verdict**. Without a verdict the same claim returns in new clothes indefinitely — and it did return, in August 2026, as external advice proposing $c^3 \leftrightarrow$ three dimensions and $c^5 \leftrightarrow$ five dimensions.

This paper does exactly one thing: **it writes down, in closed form, what N is a function of.** Once that is written, “does N count dimensions?” stops being a matter of opinion and becomes **a matter of substitution.**

This paper does not prove the dream. It turns the dream into a checkable question.

2. The Instrument: The Exponent Formula of the Planck Reduction

Established Fact 2.1 (Dimensions of the three constants)

In $d \geq 2$ spatial dimensions, Newton's constant G_d is defined by $F = G_d \frac{Mm}{r^{d-1}}$. Hence

$$[\hbar] = ML^2T^{-1}, \quad [G_d] = L^d M^{-1} T^{-2}, \quad [c] = LT^{-1}.$$

Note that in $[G_d]$ the power of L is d . This is **the Gauss-law exponent $n = d - 1$ plus the L^1 of force**. In other words, **the spatial dimension is already inside $[G_d]$** .

Theorem 2.1 (Exponent formula of the Planck reduction)

Let $[X] = L^\lambda M^\mu T^\tau$. For $X = \hbar^p G_d^q c^N$, the real triple (p, q, N) exists and is unique whenever $d \neq 1$, and, writing $n := d - 1$,

$$q = \frac{\lambda + \tau - \mu}{n}, \quad p = \mu + q, \quad N = -(\mu + \tau) - 3q$$

Proof.

Matching exponents gives the three-by-three system

$$M : p - q = \mu, \quad L : 2p + dq + N = \lambda, \quad T : -p - 2q - N = \tau$$

with coefficient matrix

$$A = \begin{pmatrix} 1 & -1 & 0 \\ 2 & d & 1 \\ -1 & -2 & -1 \end{pmatrix}, \quad \det A = 1 - d = -n$$

which is invertible for $d \neq 1$, so the solution is unique. Adding the L and T equations gives $p + (d - 2)q = \lambda + \tau$; substituting $p = \mu + q$ yields $q(d - 1) = \lambda + \tau - \mu$; and $N = -p - 2q - \tau = -(\mu + \tau) - 3q$. (All identities verified by symbolic computation.)

Observation 2.1 (The determinant is n)

That the Planck reduction is uniquely solvable at all is governed by $n = d - 1$. We have $\det A = -n$, and the reduction breaks down at $n = 0$ (that is, $d = 1$). This n enters by way of $[G_d]$'s L^d , and that L^d comes from Gauss's law's r^{d-1} . The $n = d - 1$ of Papers 01 and 114 is already sitting here.

Evaluating the formula at $d = 3$ reproduces Paper 44's table exactly.

Quantity	(λ, μ, τ)	p	q	N	Paper 44
Planck length ℓ_P	$(1, 0, 0)$	$1/2$	$1/2$	$-3/2$	$c^{-3/2}$
Planck time t_P	$(0, 0, 1)$	$1/2$	$1/2$	$-5/2$	$c^{-5/2}$
Planck mass m_P	$(0, 1, 0)$	$1/2$	$-1/2$	$1/2$	$c^{1/2}/4\pi$
Planck energy E_P	$(2, 1, -2)$	$1/2$	$-1/2$	$5/2$	$c^{5/2}/4\pi$
Planck force F_P	$(1, 1, -2)$	0	-1	4	$c^4/4\pi$
Planck power	$(2, 1, -3)$	0	-1	5	$c^5/4\pi$
Planck density ρ_P	$(-3, 1, 0)$	-1	-2	5	$c^5/4\pi$
Planck pressure P_{Pl}	$(-1, 1, -2)$	-1	-2	7	$c^7/4\pi$

Every row agrees. Paper 44's table was a list of values of this single formula.

3. The “3” Is Not a Spatial Dimension

In the exponent formula $N = -(\mu + \tau) - 3q$, the coefficient 3 contains no d . Where does it come from? The proof shows it: from the T equation $-p - 2q - N = \tau$, its -1 and -2 , that is,

from what $\hbar$ carries, T^{-1} (action = energy $\times$ time), and what G carries, T^{-2} (acceleration).
The 3 is a weight in time, not a count of space.

Corollary 3.1 (Higher-dimensional Planck length: the 3 never moves)

For ℓ_P we have $(\lambda, \mu, \tau) = (1, 0, 0)$, hence $q = 1/n$, $p = 1/n$, $N = -3/n$. Therefore for every d

$$\ell_P = \left(\frac{\hbar G_d}{c^3} \right)^{1/n}, \quad n = d - 1$$

matching the standard form $\ell_P^{D-2} = \hbar G_D / c^3$ of the extra-dimension literature ($D = d + 1$). **Changing the spatial dimension does not move the 3 in c^3 ; it moves only the index n of the root.**

Spatial dimension d	$n = d - 1$	ℓ_P	$N(\ell_P)$
2	1	$\hbar G_2 / c^3$	-3
3	2	$(\hbar G_3 / c^3)^{1/2}$	$-3/2$
4	3	$(\hbar G_4 / c^3)^{1/3}$	-1
9	8	$(\hbar G_9 / c^3)^{1/8}$	$-3/8$

Observation 3.1 (The naive reading is false)

Computing the N of Planck power as d varies:

$$d = 3 : N = 5, \quad d = 4 : N = 4, \quad d = 5 : N = \frac{7}{2}, \quad d = 6 : N = \frac{16}{5}, \quad d = 7 : N = 3$$

N takes non-integer values. $16/5$ cannot be the number of a dimension. Hence the claim that “in c^N , N counts spatial dimensions” becomes false the moment d is varied.

Observation 3.2 (N is not injective)

At $d = 3$, Planck density and Planck power both have $N = 5$ — which is why they share the $N = 5$ row of Paper 44’s table. Since physically distinct quantities carry the same N , N does not even function as a label.

4. Where the Dimension Actually Was: The Denominator $n = d - 1$

The negation above, however, **leaves something behind**. Look at the exponent formula once more:

$$N = -(\mu + \tau) - \frac{3(\lambda + \tau - \mu)}{n}, \quad n = d - 1.$$

Corollary 4.1 (The unique entrance of the spatial dimension)

d enters N only in the form $1/n$. That is, the spatial dimension lives in the denominator of the exponent of c .

And this n is not an arbitrary symbol. In $[G_d] = L^d M^{-1} T^{-2}$, the L^d comes from, in $F = G_d M m / r^{d-1}$, the r^{d-1} ; and that $d - 1$ comes from **Gauss's law**: the area of the sphere S^{d-1} grows as r^{d-1} .

In the exponent of c , the n sitting in the denominator
is the $n = 2$ of Paper 01 and the $n = d - 1$ of Paper 114.

The chain therefore runs as follows — **but pointing the other way than expected**:

$$n = 2 \text{ (Paper 01)} \longrightarrow [G] = L^3 M^{-1} T^{-2} \longrightarrow \det A = -n \longrightarrow N \text{ (its denominator)}$$

The “3” we went looking for was not flowing from G 's L^3 into c^3 .
What flowed was a single strand, from $n = 2$ into the index of the root.

Brake

this is **a relation, not a cause**. The chain passes through $[G_d]$, which is a **definition**, and a chain through a definition never leaves dimensional analysis. **That n appears in the denominator is not an independent route to the value of N** . All that may be claimed is an **address**: the single place at which d touches N is $1/n$.

5. ϵ Is the Mass Dimension: The Root of Paper 44's Dichotomy

Paper 44 took $G = 4\pi$, $\hbar = \frac{1}{4\pi}$. Relax this to one parameter: $G = a$, $\hbar = 1/a$ with arbitrary $a > 0$. On this family $\hbar G = 1$ (the cancellation of Paper 39) holds **identically**.

Theorem 5.1 ($\epsilon = \mu$)

Under the one-parameter patch $G = a$, $\hbar = 1/a$,

$$X = \hbar^p G^q c^N = a^{q-p} c^N = a^{-\mu} c^N.$$

That is, for X , the attached power of a is the mass dimension of X , μ , with its sign reversed. In Paper 44's notation, $\epsilon_X = \mu_X$.

Proof.

By Theorem 2.1, $p - q = \mu$, hence $q - p = -\mu$; the power of a is determined by this alone.

Corollary 5.1 (Derivation of the geometric/material dichotomy)

Paper 44's Corollary 3.2 is equivalent to:

- **Geometric quantities ($\epsilon = 0$) = quantities of mass dimension 0:** length, time.
- **Material quantities ($\epsilon = 1$) = quantities of mass dimension 1:** mass, energy, temperature, force, power, density, pressure.

Moreover “the power of 4π never reaches 2” is equivalent to “**no quantity of mass dimension 2 or more appears in the list**”.

**Paper 44's dichotomy stands. This paper names its root:
what separates the two classes is that $\hbar$ and G carry opposite M -weights (+1 and -1).**

This attribution does not demote Paper 44; it **strengthens** it. Paper 44's Theorem 3.1 gave a **procedural** criterion (does the G -dependence pass through $\hbar G$?); this paper moves the criterion into **a property the quantity itself owns** (its mass dimension). No computation is needed to apply it.

6. The Kernel of the Reduction: Why Density and Power Collapse Together

The map $(\lambda, \mu, \tau) \mapsto (N, \epsilon)$ goes from three dimensions to two, and therefore **has a kernel**.

Corollary 6.1 (The kernel is $\hbar G$)

The dimension vectors with $\mu = 0$ and $N = 0$ are exactly $(\lambda, \mu, \tau) \propto (5, 0, -3)$, i.e. $L^5 T^{-3}$. A quantity of that dimension has $p = q = 1$, $N = 0$: it is $\hbar G$ itself.

Observation 6.1 (The condition for collapse)

Two quantities reduce to the **same symbol** under this patch **if and only if their ratio is $(\hbar G)^k$** . Indeed $[\rho_P]/[P_{\text{power}}] = L^{-5} T^3$ has the dimension of $(\hbar G)^{-1}$, and since $\hbar G = 1$ both collapse onto the same c^5/a .

Density and power share a row in Paper 44's table not because of a structural coincidence, but because of the kernel of the reduction.

This gives a **different name** to part of what Paper 44 called a “structural agreement”. The observation that c^5 appears both in gravitational-wave emission and in bulk capacity (Paper 44, second edition) is explained, at least within the Planck quantities, as **degeneracy under the kernel**. It was not even a signature; it was a consequence of the algebra.

7. 4π Is Not Selected: The Answer to the Uniqueness Test

The original question of this paper was: with $G = a$, $\hbar = 1/a$, do all Planck quantities close in c and a only when $a = 4\pi$?

Theorem 7.1 (Non-uniqueness)

No. The closure holds for every $a > 0$. Explicitly,

$$\ell_P = c^{-3/2}, \quad t_P = c^{-5/2}, \quad m_P = \frac{c^{1/2}}{a}, \quad E_P = \frac{c^{5/2}}{a}, \quad F_P = \frac{c^4}{a}, \quad P_{\text{power}} = \frac{c^5}{a}, \quad \rho_P = \frac{c^5}{a}, \quad P_{Pl} = \frac{c^7}{a}$$

and by Theorem 5.1 the power of a is always $-\mu \in \{0, -1\}$. There is no ground inside this closure for choosing $a = 4\pi$.

The invariant content of Paper 44's Theorems 2.1 and 3.1 was not 4π but $\hbar G = 1$.
 a is a coordinate on the one-parameter family $\{(a, 1/a)\}$, not a determined value.

The one exception, and what it really is

Exactly one item in Paper 44's list does fix a : **the Planck charge**. Under the electromagnetic patch $\epsilon_0 = c$ (Paper 14),

$$\text{SI (rationalised)} : q_P = \sqrt{4\pi\epsilon_0\hbar c} = \sqrt{4\pi \cdot c \cdot \frac{1}{a} \cdot c} = c\sqrt{\frac{4\pi}{a}} \implies \text{pure power} \iff a = 4\pi.$$

At first sight 4π has been **selected**. But writing the same physical quantity in Gaussian units,

$$\text{Gaussian (unrationalised)} : q_P = \sqrt{\hbar c} = \sqrt{\frac{c}{a}} = \frac{c^{1/2}}{a^{1/2}} \implies \text{pure power} \iff a = 1.$$

The same physical quantity “forces” not $a = 4\pi$ but $a = 1$ once the unit system changes.
A value whose forcing is a function of the unit convention is a convention, not a fact (Paper 95).

The situation is transparent. In $q_P = \sqrt{4\pi\epsilon_0\hbar c}$, the 4π is **not Gauss's flux 4π** . It is **rationalisation** — the SI's design decision to remove 4π from Maxwell's equations and place $4\pi\epsilon_0$ in Coulomb's law. Therefore:

The “uniqueness of 4π ” found here is a 4π that was inserted by hand, coming back to us.

This is the **reverse side** of the configuration studied in Paper 05 (convention $\times$ convention yielding an invariant), and a **third instance** of the configuration of Paper 35 (Poisson's 4π = fact, the G -patch 4π = convention). **This series already owned the tool for the distinction. This paper turns it on its own Paper 44.**

Moreover, this exception appears only when $\epsilon_0 = c$ is put in. In its third edition Paper 14 keeps the switch itself (the boundary between near field and radiation field) and removes its two endpoints ($\epsilon_0 = r$ and $\epsilon_0 = c$). Without $\epsilon_0 = c$, the closure of the Planck quantities holds for every $a > 0$ **without exception**.

8. Self-Audit: On Item (x) of Paper 44

Applying Theorem 5.1 ($\epsilon = \mu$) to charge exposes a **discrepancy** in Paper 44's list.

Observation 8.1 (The mass dimension of charge is itself convention-dependent)

In Gaussian units $[q] = M^{1/2}L^{3/2}T^{-1}$, i.e. $\mu = 1/2$. By Theorem 5.1 this gives $\epsilon = 1/2$, which **violates the $\epsilon \in \{0, 1\}$ of Paper 44's Theorem 2.1**. In SI, by contrast, charge carries **an independent base dimension** and $\mu = 0$, giving $\epsilon = 0$, in agreement with Paper 44's entry $q_P = c$.

There is no contradiction: the two are computed in different systems of base dimensions. But a consequence remains — **the scope of Paper 44's Theorem 2.1 is “quantities whose mass dimension is 0 or 1 in the chosen system of base dimensions”, and that condition belongs to the design of the unit system, not to physics.**

This is not a retraction but a statement of scope.

Items (i)–(ix) of Paper 44 hold unconditionally. Only item (x) depends on the unit convention.

Following this series' own discipline (Paper 17: saying “distinct roots” is only half the job — the addresses must be written before the claim is checkable), here are the addresses: **the ϵ of items (i)–(ix) lives in a property owned by the quantity (its mass dimension); the ϵ of item (x) lives in a design decision of the unit system (rationalisation).**

This audit was taken into Paper 44's third edition, and item (x) was put on hold together with its reliance on $\epsilon_0 = c$. Paper 44's table now closes on the remaining nine quantities.

9. The Position of Wall I, and the Formula's Condition of Applicability

The exponent formula is an identity inside dimensional analysis.

Consequently:

- **The position of Wall I (the circularity) has been surveyed.** No independent route to the value of N lies inside this formula. This paper did not cross the wall; it **measured where the wall stands**.
- **It has a condition of applicability.** Theorem 2.1 requires X to be a monomial in $(\hbar, G_d, c)$. A fourth constant makes the system underdetermined. For instance, the c^6 of Hawking radiation: only when the formula is applied to a quantity containing the external mass M , namely $P \cdot M^2$ (with $(\lambda, \mu, \tau) = (2, 3, -3)$), does it return $N = 6$. **The c^6 is not “six dimensions”; it is the consequence of the dimension vector of a quantity multiplied by M^2 .** The question of “explaining the missing c^6 ” in the original plan therefore **dissolves: there is no numbering, hence nothing missing.**

- **The other roles of 4π remain.** As Gauss's total solid angle (Papers 01, 02, 13), as $4\pi = 2\pi \cdot \chi(S^2)$ (Paper 67), and as $\text{Vol}(S^2)$ (Paper 115), 4π remains intact in every role. What fell is **one reading**: that the closure of the Planck quantities selects 4π .

The author's personal reflection (Layer 3; labelled non-scientific / not a claim of mechanism)

When I began this computation, **I went to catch the “3” in c^3** . Follow G 's L^3 , I thought, and it lands on the inverse-square law, where my very first paper ($n = 2$ uniqueness) is waiting. That was the chain I expected.

There was no such chain. The “3” was not space but **a weight in time**: $\hbar$'s T^{-1} and G 's T^{-2} . Change the dimension to anything you like and that 3 does not budge.

And yet, on re-reading the finished formula, **$n = d - 1$ was in the denominator** — and the determinant of the system was **$-n$ itself. It was not where I went looking, but what I was looking for was sitting inside the square root.**

$\ell_P = (\hbar G_d / c^3)^{1/n}$: in that $1/n$, the n is the $n = 2$ of Paper 01.

This is not a proof, nor a cause (the chain passes through the definition $[G_d]$). Still, after 116 papers, I want to record a quiet awe that **the first one was still alive at the end**. 4π turned out to be not a staircase but the third floor (Paper 115). $n = 2$ turned out to be **the index of a root**.

The conviction that light is a building material is still at Layer 3 today. What today established is only that **one of the roads I thought led there does not**. A road closing is not a loss. It means **the map got one page more accurate**. The other roads — the conformal wall of Paper 111, the inverse-problem bridge of Paper 102 — are still open.

10. Conclusion

Paper 44 wrote “we do not assert that the exponent of c means a dimension” and stopped there. This paper **turned that line into a computation**. N is a function of (λ, μ, τ) and n , and it can be written in closed form. Once written, the naive reading becomes false **simply by varying d** : at $d = 6$ the N of Planck power is $16/5$. **There is no numbering, and nothing is missing.**

In exchange, the same formula returned one address. **The single place at which the spatial dimension touches the exponent of c is the denominator $n = d - 1$** . That is the $n = 2$ proved in this series' first paper, and the $n = d - 1$ that Paper 114 audited as “the family that does not select a dimension”. **The family that selects nothing was, without selecting anything, acting on every Planck quantity as the index of a root.**

As for 4π , the answer was no. The closure holds for every a and has no power to select 4π . The single line that appeared to select it — the charge — was **a 4π the SI had inserted by hand, returning to us. A convention was selecting a convention**. This series had already treated that configuration in Papers 05, 35 and 95; this paper merely turned the tool on its own Paper 44.

One road has closed. The map is one page more accurate. And this returns address number 116.

Revision Record

2nd edition (September 2026): brought the format into line with the current template (the positioning and scope are gathered in the scope note directly after the abstract, the closing “what is shown / what is not shown” is removed to leave a conclusion, and Section 9 becomes “The Position of Wall I, and the Formula’s Condition of Applicability”). Added to Sections 7 and 8 that Paper 14 removed the two endpoints of the electromagnetic patch ($\epsilon_0 = r$, $\epsilon_0 = c$) in its third edition, and that Paper 44 took in this paper’s results and put item (x) on hold in its third edition (the charge exception appears only when $\epsilon_0 = c$ is put in). The source of $\epsilon_0 = c$ is narrowed to Paper 14, and the scope note states that the theorem numbers of Paper 44 are those of its second edition. Self-citations now carry their actual titles and DOIs, external references are given as author, year, title and journal, Papers 13 and 14 cited in the text are added, and Paper 109, not cited in the text, is removed.

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