

How Many “Base” Units There Are Is a Promise

— The Same Physics Carries **7** Base Dimensions or **0**, Depending on the System — The 4π Moves House Three Ways, and One of the Seven Comes from Human Physiology — [Paper 306]

Yuuki YAMAGISHI (山岸 勇輝)

Yamagishi Complexity Torus Lab, Japan

August 2026

— *From thinking to syncing.* —

Abstract

The SI has seven base units. The word “base” sounds as though it meant irreducible. This paper asks where the number seven came from—the answer is from a promise. No new mathematical theorem and no new law is claimed. First, the count of base dimensions changes with the system. **7** in SI, **3** in Gaussian, **0** in Planck units (Section 2). Second, this is the core of the paper. The same physics carries anywhere from **7** to **0** base dimensions—only the writing changed (Section 2). Third, two of the seven are not logically independent. The mole is a count, and the candela is a watt times **683** (Section 3). Fourth, one comes from human physiology. The **683** lm/W is the value at **555** nm, where human photopic sensitivity peaks (Section 3). Fifth, the 4π moves house too. In Coulomb’s law it appears in SI, vanishes in Gaussian, and leaves the field equations in Heaviside–Lorentz (Section 4). Sixth, the separator is the order of measurement against logical independence (Section 5).

Scope of this paper (scope note): No new mathematical theorem and no new law is claimed—the seven SI base units, the Gaussian, natural and Planck systems, and the 2019 redefinition are all standard. We do not build metrology—all we use is a count of dimensions and one wavelength. We do not rank the systems—neither which is right nor which should be used is treated. Only that the count changes. We do not build dimensional analysis—we do not enter the Buckingham Π theorem; that is the side of Paper 117. We do not criticise the SI—choosing seven is practically reasonable. Logical independence is not the only criterion. We do not call the candela unnecessary—photometry is a separate practice from radiometry, and fixing 683 by convention has a purpose. This paper says only that the provenance of that number differs from the other six. We do not recommend Planck units—having 0 base dimensions is neither a merit nor a defect. It is set down to show that it can be counted. Relation to earlier papers: Paper 95 separated convention from fact and treated the defined value of c —this paper counts that there are seven such conventions, and that the count itself is one. Paper 295 showed that the molar mass of carbon-12 is no longer exactly 12—this paper asks whether the mole needs a dimension at all. Paper 116 treated what the exponent of c counts and touched the non-uniqueness of 4π —Section 4 here views that non-uniqueness from the side of unit systems. Papers 02, 258 and 290 treated the provenance of 4π —this paper lines up how 4π changes house with the system. What is added is counting the base dimensions of five systems as 7, 3, 3, 1, 0, showing that two of the seven are not logically independent, pointing out that 683 is the only number coming from human physiology, and lining up the three houses of 4π .

1. Notation and the Question

Fact: The SI has seven base units—metre, kilogram, second, ampere, kelvin, mole, candela.

Question: Where did the number seven come from? Does nature demand seven?

Observation 1.1

The word “base” sounds as though it meant irreducible. This paper regards that as imprecise—they are not irreducible; it was decided not to reduce them.

2. The Core: The Same Physics Runs from 7 to 0

Check 2.1:

System	Base dimensions	Base quantities
SI	7	m, kg, s, A, K, mol, cd
Gaussian (CGS)	3	cm, g, s
Heaviside--Lorentz	3	cm, g, s
Natural ($\hbar = c = 1$)	1	energy alone
Planck	0	everything dimensionless

Observation 2.2

This is the core of the paper. The same physics runs from **7** base dimensions to **0**—only the writing changed; nothing in the phenomena did.

Check 2.3: We write the staircase down.

What is done	Base dimensions left
SI (as is)	7
Drop mol and cd	5
Reduce A to mechanics (Gaussian)	3
Set $\hbar = c = 1$	1
Set $G = 1$ as well (Planck)	0

Observation 2.4

At each step something is fixed by convention. Setting $c = 1$ is the promise that length and time share a dimension—nature did not demand it; we decided it.

Check 2.5: We look numerically at the Planck system.

Quantity	Value
Planck length	1.616255×10^{-35} m
Planck time	5.391246×10^{-44} s
Planck mass	2.176434×10^{-8} kg
Planck temperature	1.416784×10^{32} K

Observation 2.6

Set these to 1 and the base dimensions number 0. Every quantity becomes a bare number—and the physics does not change.

3. Two of the Seven Are Not Logically Independent

Observation 3.1

The mole is a count. $N_A = 6.02214076 \times 10^{23}$ is a number, and since 2019 it is defined to be exactly that (Paper 295)—whether to give a count a dimension is a promise.

Observation 3.2

The candela is a watt times a constant. Luminous intensity [cd] = 683× radiant intensity [W/sr] × $V(\lambda)$ —no new dimension is introduced.

Check 3.3: Since 2019 all seven are defined by fixed constants.

Unit	Constant fixed	Value	Provenance
Second	Cs-133 hyperfine transition	9192631770 Hz	physics
Metre	<i>c</i>	299792458 m/s	physics
Kilogram	<i>h</i>	6.62607015 $\times 10^{-34}$ J s	physics
Ampere	<i>e</i>	1.602176634 $\times 10^{-19}$ C	physics
Kelvin	<i>k</i>	1.380649 $\times 10^{-23}$ J/K	physics
Mole	<i>N_A</i>	6.02214076 $\times 10^{23}$ /mol	physics
Candela	<i>K_{cd}</i>	683 lm/W	human physiology

Observation 3.4

In the rightmost column, only the last row differs. The **683 lm/W** is the luminous efficacy at **555 nm**, and **555 nm** is where human photopic sensitivity peaks—one of the seven comes from us.

Observation 3.5

The value **683** also comes from history. It was chosen to preserve continuity with the old definition (a **1/60 cm²** blackbody at the freezing point of platinum)——no physical necessity anywhere.

Observation 3.6

So the base units were not chosen by logical independence. The criterion was the practice of measurement ——which quantities are measured directly and which are assembled.

Observation 3.7

A point to write honestly——this is not a defect of the SI. Photometry is a separate practice from radiometry, and fixing **683** by convention has a purpose——this paper says only that the standing of that number differs from the other six.

4. The 4π Moves House by Promise Too

Setting: We write Coulomb’s law in three systems.

Check 4.1:

System	Coulomb’s law	The 4π
SI	$F = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2}$	appears in the force law
Gaussian	$F = \frac{q_1q_2}{r^2}$	vanishes
Heaviside--Lorentz	$F = \frac{q_1q_2}{4\pi r^2}$	leaves the field equations

Observation 4.2

One and the same physics gives the 4π three houses. In Gaussian units it leaves the force law; in Heaviside--Lorentz it moves to Gauss’s law—it did not vanish; it moved.

Observation 4.3

Paper 02 showed a pure solid angle 4π appearing in inverse-square fields; Paper 258 wrote that it appears only when the source is a point. In Paper 290 it stood twice and cancelled——this paper adds that changing the system moves its house.

Observation 4.4

So 4π has two standings.

	Provenance	Moves with the system?
Geometric 4π	the solid angle of a sphere	no
Conventional 4π	the choice of unit system	yes

Observation 4.5

The test is simple——change the system: if it vanishes it is convention, if it stays it is geometry. This has the same shape as Paper 31’s criterion (move the variable)——the variable being moved here is the unit system.

5. Separator: The Order of Measurement against Logical Independence

Observation 5.1

Separator——what must be moved for the count of base dimensions to change? What one fixes by convention.

Meaning of “base”	What is counted	Answer for SI
Order of measurement	quantities measured directly	7
Logical independence	irreducible dimensions	5 or fewer
Convention maximised	fix every constant one can	0

Observation 5.2

All three rows are correct. To “how many base units are there” one may answer 7, or 5, or 0——without saying in which sense, the answer is not determined.

Observation 5.3

Paper 95 separated convention from fact. What this paper adds is one further step: the number of conventions is itself a convention——what sets the height of the scaffolding is also scaffolding.

Observation 5.4

Paper 295 showed that the 2019 revision moved an equals sign from definition to empirical law. This paper sees another face of that revision—with all seven defined by numbers, “base” purified into the order of measurement.

Observation 5.5

Before 2019 the kilogram was an object (the international prototype). Now all seven are numbers—not one thing remains on the list of base units.

Observation 5.6

A point to write honestly—this paper does not say the seven should be reduced. In practice the order of measurement carries meaning—what can be said is only that the seven is not a demand of nature.

6. Roll Call and Closing

1. **7 in SI, 3 in Gaussian** (Check 2.1): **0 in Planck.**
2. **The staircase runs 7, 5, 3, 1, 0** (Check 2.3): **Each step fixes something.**
3. **Planck length 1.616255×10^{-35} m** (Check 2.5): **Set to 1, all dimensionless.**
4. **The mole is a count** (Observation 3.1): **Giving it a dimension is a promise.**
5. **The candela is a watt $\times 683$** (Observation 3.2): **No new dimension.**
6. **683 is the value at 555 nm** (Observation 3.4): **The peak of human sensitivity.**
7. **683 came from history** (Observation 3.5): **Continuity with the old definition.**
8. **4π has three houses** (Check 4.1): **It moved, it did not vanish.**
9. **Vanishing with the system means convention** (Observation 4.5): **Paper 31’s test.**
10. **The answer is 7, 5, or 0** (Observation 5.2): **Depending on the sense.**

Closing: That the SI has seven base units is not because nature demands seven. The same physics can be written with **3** base dimensions in Gaussian units, **1** in natural units, and **0** in Planck units—only the writing changed; nothing in the phenomena did. And two of the seven are not logically independent—the mole is a count, and the candela is a watt times **683**. And one comes from us—the **683 lm/W** is the value at **555 nm**, where human photopic

sensitivity peaks. The other six (C_s , c , h , e , k , N_A) are physical constants; this one is physiological. The 4π moves the same way—in SI it sits in the force law, in Gaussian it vanishes, in Heaviside–Lorentz it moves to the field equations. It did not vanish; it moved house. One thing separates them—whether “base” is read as the order of measurement or as logical independence. On the first reading the answer is **7**; on the second, **5** or fewer; maximising convention, **0**. All three are correct, and without saying in which sense, the answer is not determined.

References

1. Bureau International des Poids et Mesures (2019). *The International System of Units (SI)*, 9th edition. Sevres: BIPM.
2. Gauss, C. F. (1832). Intensitas vis magneticae terrestris ad mensuram absolutam revocata. *Commentationes Societatis Regiae Scientiarum Gottingensis Recentiores*, 8.
3. Planck, M. (1899). Über irreversible Strahlungsvorgänge. *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften*, 5.
4. Jackson, J. D. (1998). *Classical Electrodynamics*. New York: Wiley.
5. Duff, M. J., Okun, L. B. and Veneziano, G. (2002). Dialogue on the Number of Fundamental Constants. *Journal of High Energy Physics*, 2002(03).
6. Commission Internationale de l’Eclairage (1926). *Proceedings of the 6th Session*. Geneva: CIE.
7. Yamagishi, Y. (2026). *The 4π Mass Cancellation Theorem* [Paper 02]. Zenodo. 10.5281/zenodo.21403931
8. Yamagishi, Y. (2026). *The π That Carries No Dimension* [Paper 31]. Zenodo. 10.5281/zenodo.22090430
9. Yamagishi, Y. (2026). *Convention and Fact* [Paper 95]. Zenodo. 10.5281/zenodo.21758621
10. Yamagishi, Y. (2026). *What Does the Exponent of c Count?* [Paper 116]. Zenodo. 10.5281/zenodo.22003794
11. Yamagishi, Y. (2026). *4π Appears Only When the Source Is a Point* [Paper 258]. Zenodo. 10.5281/zenodo.22169011
12. Yamagishi, Y. (2026). *The Molar Mass of Carbon-12 Is No Longer Exactly 12* [Paper 295]. Zenodo. 10.5281/zenodo.22171659

— From thinking to syncing. —

Yuuki YAMAGISHI (山岸 勇輝)