

Zero-Tension Does Not Act on an Identity

— 3rd Edition: The Standing of the Mass Shell Depends on Which Theory One Stands Inside — [Paper 21]

Yuuki YAMAGISHI (山岸 勇輝)

Yamagishi Complexity Torus Lab, Japan

August 2026 (3rd Edition)

— *From thinking to syncing.* —

ABSTRACT

This paper substituted $m_0 = 4\pi$ into the relativistic energy–momentum relation to write $E^2 = (pc)^2 + (4\pi c^2)^2$, and the first edition called the rearranged form $E^2 - (pc)^2 - (4\pi c^2)^2 = 0$ a "zero-tension condition", claiming an isomorphism with the light cone $ds^2 = 0$. The second edition withdrew that isomorphism. **The 3rd edition names why it could not be called a condition at all. First, zero-tension does not act on an identity.** As Paper 89 identified, zero-tension is the stance of holding a null hypothesis that can be violated and reading the cause off its deviations. But $E^2 - (pc)^2 - (m_0 c^2)^2 = 0$ is merely a rearrangement and cannot be violated. With no deviation to read, the stance cannot be applied to this expression. In the census of the 3rd edition of Paper 16, the first edition read root (c), an identity, as root (d), a conditional. **Second, the standing of the same expression depends on which theory one stands inside. Inside** special relativity the mass shell is an identity. **Outside** it, it becomes a testable null hypothesis against modified dispersion relations such as $E^2 = p^2 c^2 + m^2 c^4 + \eta p^3 c^3 / E_{QG}$ — testable as an arrival-time difference for high-energy photons from distant gamma-ray bursts (the estimate here gives about 0.1 s for 10 GeV at $z \sim 1$ with $E_{QG} = E_{Pl}$). **This is where zero-tension does act. Whether something is an identity or a hypothesis is not settled by how the equation looks, but by where one stands. Third, the relation between the four-momentum and the four-displacement is neither an "isomorphism" nor "unrelated".** Since $p^\mu = m_0 u^\mu$ with $u^\mu = dx^\mu / d\tau$, the two are norms of the tangent to the same worldline under the same metric, related by the factor $m_0 / d\tau$. The light cone is not a matter of "a different vector": it is where that proportionality breaks down as $d\tau \rightarrow 0$. The second edition's "norms of different vectors" did not say enough. **Fourth, reading $4\pi c^2$ as "the surface area of a sphere of radius c " requires making c a length.** But as the 3rd edition of Paper 39 established, the three slots of the budget against M, L, T are already spent on $m = 4\pi, G = 4\pi, \hbar = 1/(4\pi)$, so c is no longer choosable. To read it that way, one must declare a fourth choice explicitly (Paper 63). **Scope:** a structural account within established physics (Layer 2). **This paper does not modify relativity and claims no isomorphism with the light cone.**

Positioning of this paper (discipline): This paper offers a **structural interpretation** of established physical laws. It claims neither the discovery of new physical laws nor the proof of open problems. The relations shown are transformations of known expressions; the aim is to propose a structural reading of them. No claim contradicting established theory is made. **The appearance of the same number in several contexts is not treated as evidence of a common origin** (Papers 48, 86, 100, 115). $m_0 = 4\pi$ and the like are conventional choices within a system of units, not new facts about nature (Papers 35, 38, 95).

1. Introduction: what this paper called a "condition"

Substituting $m_0 = 4\pi$ into the relativistic energy–momentum relation gives $E^2 = (pc)^2 + (4\pi c^2)^2$. As a substitution this is correct. The first edition rearranged it as $E^2 - (pc)^2 - (4\pi c^2)^2 = 0$ and called this a "zero-tension condition", claiming an isomorphism with the light cone $ds^2 = 0$. The second edition withdrew that isomorphism and wrote that "this is merely a rearranged identity, not a condition".

That observation was right. But it stopped there.
The 3rd edition names why it could not be called a condition.

2. Zero-tension does not act on an identity

Established Fact 2.1 (What zero-tension was — Paper 89)

Paper 89 identified **zero-tension** — a word the author brought from the world of angling — as, within this series, a stance towards inverse problems: hold a null hypothesis that can be violated (the state in which nothing is happening), and read the deviations from it as the cause. It has the same structure as taking the slack of the line as the baseline and reading whatever departs from it as the movement of the fish.

Corollary 2.2 (It cannot be applied to what cannot be violated)

$E^2 - (pc)^2 - (m_0c^2)^2 = 0$ is the energy–momentum relation itself, rearranged, and holds for every particle always.

The deviation is therefore guaranteed to be zero. There is, by definition, nothing to read. The stance of zero-tension does not operate on this expression — it is not that the line does not go slack; there is no line.

In the census of the 3rd edition of Paper 16, the first edition read root (c), an identity, as root (d), a conditional. The form " $= 0$ " looked like a condition. Form does not tell you the root.

This is a worked instance of the series' third check (Paper 16). On seeing quantities joined by "=", ask first what would have to be the case for it to be false. If nothing could make it false, it says nothing about the world.

3. The standing of the mass shell depends on which theory one stands inside

Observation 3.1 (The same expression: an identity inside, a hypothesis outside)

Standing inside special relativity, $E^2 - (pc)^2 - (m_0c^2)^2 = 0$ is a rearranged identity. It cannot be violated.

Standing outside it, the same expression becomes a testable null hypothesis. Some candidate theories of quantum gravity predict modified dispersion relations

$$E^2 = p^2c^2 + m^2c^4 + \eta \frac{p^3c^3}{E_{\text{QG}}} + \dots,$$

which shift the group velocity of high-energy photons slightly. For distant gamma-ray bursts this appears as a difference in arrival time (Amelino-Camelia et al. 1998).

The estimate here: assuming a first-order effect $\delta v/c \simeq E/E_{\text{QG}}$ with $E = 10$ GeV and $E_{\text{QG}} = E_{\text{Pl}} = 1.22 \times 10^{19}$ GeV gives $\delta v/c = 8.2 \times 10^{-19}$. Over a redshift $z \sim 1$ (a distance $\sim 3.9 \times 10^{25}$ m) the arrival-time difference is $\Delta t \simeq (D/c)(\delta v/c) \approx 0.1$ s. A delay of that size is within observational reach, and the Fermi-LAT observation of GRB 090510 constrained E_{QG} for the first-order effect to above the Planck energy (Abdo et al. 2009).

Corollary 3.2 (This is where zero-tension acts)

The mass shell becomes a null hypothesis that can be violated only when viewed from outside special relativity. There a deviation can be defined — which is exactly why it can be pushed on by experiment.

Whether something is an identity or a hypothesis is not settled by how it looks, but by where one stands. The first edition's error was to read the form " $= 0$ " as a condition; the second edition corrected it to an identity; what the 3rd edition adds is the further step that the same expression becomes a hypothesis from outside.

This paper, however, performs no such test. It proposes no modified dispersion relation and claims nothing about E_{QG} . What it shows is confined to a question of position: from where can a deviation be read.

4. The exact relation between four-momentum and four-displacement

As its reason for withdrawing the isomorphism, the second edition wrote that "the two are norms of different vectors (the four-momentum p^μ and the four-displacement dx^μ)". That did not say enough.

Established Fact 4.1 (They are norms of the tangent to the same worldline)

For a massive particle,

$$p^\mu = m_0 u^\mu, \quad u^\mu = \frac{dx^\mu}{d\tau}, \quad u^\mu u_\mu = -c^2,$$

so that $p^\mu p_\mu = m_0^2 (u^\mu u_\mu) = -m_0^2 c^2$ follows identically. Meanwhile $dx^\mu dx_\mu = -c^2 d\tau^2$, so $ds^2 = 0 \iff d\tau = 0$.

The two are therefore not "different vectors" — they are norms, under the same metric, of the tangent to the same worldline, related by the factor $m_0/d\tau$.

Observation 4.2 (The light cone is where that proportionality breaks down)

As $m_0 \rightarrow 0$ the parametrisation by τ ceases to exist at all — a null worldline has no proper time. The light cone is not "a matter of a different vector": it is where the correspondence $p^\mu = m_0 dx^\mu/d\tau$ itself ceases to be definable.

The first edition's "isomorphism" went too far; the second edition's "unrelated" did not go far enough. Precisely, they are two parametrisations of the same object, and the light cone is the boundary at which one of them disappears.

This is of the same type as the module boundary of Paper 113 — the description changes where the dimensionless quantity $m_0 c/|p|$ reaches 0. But as with the $\nu \rightarrow 0$ of Paper 03, it is not a smooth limit (the disappearance of proper time is a singular change).

Numerical check ($m_0 = 4\pi$, $c = 1$, computed here): for $v/c = 0, 0.5, 0.9, 0.999$ the value of $E - pc$ is 12.566, 7.255, 2.883, 0.281 — approaching 0 but never reaching it. So long as $m_0 \neq 0$ the state is always inside the light cone.

5. Withdrawing the link to Paper 16 — and why it happened

The first edition substituted $p = 4\pi v$ from Paper 16 to obtain $E^2 = (4\pi c)^2(v^2 + c^2)$; the second edition withdrew this. The numbers were re-verified here ($m_0 = 4\pi$, $c = 1$):

v/c	E using $p = m_0 v$	correct $E = \gamma m_0 c^2$	correct/wrong
0.01	12.567	12.567	1.00
0.30	13.120	13.173	1.00
0.50	14.050	14.510	1.03
0.90	16.906	28.829	1.71
0.99	17.683	89.081	5.04

Observation 5.1 (The type of the error was "not writing the range of validity")

$p = 4\pi v$ is a non-relativistic momentum, whereas the relativistic relation requires $p = \gamma m_0 v$. They agree only as $v \rightarrow 0$, and differ by about a factor 5 at $v = 0.99c$.

As the 3rd edition of Paper 16 noted, $p = 4\pi v$ is root (b), a consequence of substitution, and its range of validity cannot exceed that of the formula substituted into (Newtonian mechanics). The first edition carried it into a relativistic equation without writing that range.

And $\sqrt{v^2 + c^2}$ is not a Lorentz scalar. What appears in relativistic kinematics is $\sqrt{1 - v^2/c^2}$; a quantity adding a particle speed to the invariant speed is not an invariant — it is an artefact of having used $p = m_0 v$.

6. Reading $4\pi c^2$ as an "area" requires budget

The scope section of the second edition wrote that " $4\pi c^2$ takes the form of the surface area of a sphere of radius c " and referred to Paper 12. The 3rd edition adds a check of dimension and of budget.

Corollary 6.1 (Reading c as a length is a fourth choice)

$[4\pi c^2] = (L/T)^2 = L^2 T^{-2}$. To read this as an area L^2 one must have $[c] = L$, i.e. fix the unit of time.

But as the 3rd edition of Paper 39 established, the three slots of the budget against M, L, T are already spent on $m = 4\pi$, $G = 4\pi$, $\hbar = 1/(4\pi)$. So c is no longer choosable.

Reading c as a radius is itself an operation Paper 63 took as its subject, and is not forbidden. But it cannot be used without declaration — the same type of oversight the 3rd edition of Paper 17 identified for $\hbar = 1$.

The 3rd edition therefore records " $4\pi c^2$ takes the form of a surface area" as a resemblance of form only. It does not say that it is an area.

7. The three geometries of relativity — where this paper belongs

Observation 7.1 (The sorting of Paper 108)

Paper 108 took a census showing that **"the geometry of relativity"** is not one thing: **(i) Minkowski's flat invariant interval** (Paper 108), **(ii) the hyperbolic geometry of velocity space** (Paper 60), **(iii) proper time** (Paper 82). **The three are distinct roots.**

This paper's $E^2 = (pc)^2 + (m_0c^2)^2$ belongs to **(i)** — the Minkowski norm of the four-momentum. **The $\sqrt{v^2 + c^2}$ the first edition tried to import resembles a quantity of the domain of (ii), but is not a quantity of hyperbolic geometry** (the composition of velocities is not Euclidean addition). **And the light cone is where (iii) disappears (§4).**

The first edition's confusion lay in treating all three as one "geometry of relativity". The sorting of Paper 108 is, for this paper, a map supplied afterwards.

Personal reflection of the author (Layer 3; labelled non-scientific / no claim of mechanism)

In the first edition I gave a merely rearranged expression the name **"zero-tension condition"**. When the second edition corrected it to "this is an identity, not a condition", I thought I had fixed the arithmetic.

What I saw in the 3rd edition is that **what needed fixing was the name. Zero-tension is the word I brought from the world of angling — the one closest to me of all of them.** In Paper 89 I wrote it down as "the stance of holding a null hypothesis that can be violated". **Then I should not have given that name to an expression that cannot be violated.** It is not that the line did not go slack. **There was no line.**

And one more thing. **The mass shell can be violated, seen from outside relativity.** It can be pushed on by the arrival times of gamma-ray burst photons. **So there was a place where my word works after all.** It was just **outside where I had been standing.**

The same expression changes its standing with where one stands. That is my largest harvest this time. **If a name matters to me, I must write down where the name works.**

8. Scope / Conclusion

What is shown: that **zero-tension does not act on an identity** (§2; the stance of Paper 89 requires a null hypothesis that can be violated, and in the census of Paper 16 the first edition read root (c) as root (d)) / that **the same expression is an identity inside special relativity and a testable hypothesis outside it** (§3, with an estimate of the arrival-time difference under a modified dispersion relation) / that **the four-momentum and the four-displacement are norms of the tangent to the same worldline, the light cone being where the correspondence breaks down as $d\tau \rightarrow 0$** (§4) / that **failing to write the range of validity of $p = 4\pi v$ produced the false link to Paper 16** (§5, numbers re-verified) / that **reading $4\pi c^2$ as an area requires a fourth choice making c a length, and the budget is spent** (§6) / that **this paper belongs to the "geometry of the invariant interval" in the sorting of Paper 108** (§7).

What is not shown (restraint): any isomorphism with the light cone — withdrawn and outside the scope of this paper / no algebraic link with the $p = 4\pi v$ of Paper 16 / no physical meaning for $\sqrt{v^2 + c^2}$ (not a Lorentz scalar) / no proposal of a modified dispersion relation and no claim about E_{QG} (§3 is confined to a question of position) / $4\pi c^2$ is not said to be an area / no new physical law and no prediction (Layer 2).

What the 3rd edition adds is where a name works. Zero-tension can be applied only to what can be violated — and what can be violated is settled not by the equation but by where one stands.

And what remains is small.

With $m_0 = 4\pi$ one may write $E^2 = (pc)^2 + (4\pi c^2)^2$ — a consequence of substitution, not a discovery.

That the right-hand side takes a Pythagorean form follows from the signature of the Minkowski metric.

Revision Record

3rd edition (August 2026): removed the word "Withdrawal" from the title, which now names **what the paper shows**; the list of withdrawals is collected in this section.

Added in the 3rd edition: an account of why **zero-tension does not act on an identity**, drawing on Paper 89 (zero-tension as the inverse-problem stance of holding a violable null hypothesis) and the census of the 3rd edition of Paper 16 (the first edition read root (c) as root (d)) (§2). A demonstration that **the same expression is an identity inside special relativity and a testable null hypothesis outside it**, with modified dispersion relations and the arrival-time difference for distant gamma-ray bursts (about 0.1 s for 10 GeV at $z \sim 1$ with $E_{QG} = E_{PI}$) (§3). A demonstration that **the four-momentum and the four-displacement are norms of the tangent to the same worldline ($p^\mu = m_0 u^\mu$), the light cone being where the correspondence breaks down as $d\tau \rightarrow 0$** , making precise the second edition's "norms of different vectors" (§4). A note that reading $4\pi c^2$ as an area requires a fourth choice making c a length, the budget having been spent according to the

3rd edition of Paper 39 (§6). An explicit placement of this paper within **the three geometries sorted by Paper 108 (§7)**. All numbers were computed here (no external tables consulted).

Changed in the 3rd edition: the scope section of the second edition wrote that " **$4\pi c^2$ takes the form of the surface area of a sphere of radius c** ". The 3rd edition records this as a resemblance of form only and does not say that it is an area (§6).

Withdrawn in the 2nd edition (July 2026):

1. **The "isomorphism" with the light cone.** The first edition claimed that $E^2 - (pc)^2 - (4\pi c^2)^2 = 0$ is tensorially isomorphic to the light cone $ds^2 = 0$. **That claim was withdrawn in full.** (a) The expression is the energy–momentum relation itself, rearranged, holds identically for every particle, and is therefore not a "condition". (b) The light cone corresponds to $m_0 = 0$, but this paper takes $m_0 = 4\pi \neq 0$, so $E > pc$ always and $ds^2 = 0$ is never satisfied.
2. **The link with Paper 16.** The first edition substituted $p = 4\pi v$ to obtain $E^2 = (4\pi c)^2(v^2 + c^2)$, but $p = 4\pi v$ is a non-relativistic momentum whereas the relativistic relation requires $p = \gamma m_0 v$; the discrepancy is about a factor 5 at $v = 0.99c$. And $\sqrt{v^2 + c^2}$ is not a Lorentz scalar.

First edition: Zenodo 10.5281/zenodo.21601143.

References

1. Einstein, A. (1905). *Zur Elektrodynamik bewegter Körper*. Ann. Phys. 17.
2. Minkowski, H. (1908). *Raum und Zeit*. Jahresber. Dtsch. Math.-Ver. 18.
3. Amelino-Camelia, G., Ellis, J., Mavromatos, N. E., Nanopoulos, D. V., Sarkar, S. (1998). *Tests of quantum gravity from observations of gamma-ray bursts*. Nature 393.
4. Abdo, A. A. et al. (Fermi LAT/GBM Collaborations) (2009). *A limit on the variation of the speed of light arising from quantum gravity effects*. Nature 462.
5. Misner, C. W., Thorne, K. S., Wheeler, J. A. (1973). *Gravitation*. W. H. Freeman.
6. Yamagishi, Y. (2026). *Zero-Tension and the Inverse Problem* [Paper 89]. Zenodo. 10.5281/zenodo.21748664
7. Yamagishi, Y. (2026). *Reading the Interior from the Boundary* [Paper 99]. Zenodo. 10.5281/zenodo.21758790
8. Yamagishi, Y. (2026). *Extracting Signal from Noise* [Paper 106]. Zenodo. 10.5281/zenodo.21836984
9. Yamagishi, Y. (2026). *The Equals Sign Has Distinct Roots Too (3rd ed.)* [Paper 16]. Zenodo. 10.5281/zenodo.21600471
10. Yamagishi, Y. (2026). *The 8π Is an Artefact of the Units (3rd ed.)* [Paper 17]. Zenodo. 10.5281/zenodo.21600813
11. Yamagishi, Y. (2026). *A Convention Is a Number, Not a Function of the Configuration (3rd ed.)* [Paper 15]. Zenodo. 10.5281/zenodo.21600352

12. Yamagishi, Y. (2026). *The Geometry Where the Invariant Lives* [Paper 108]. Zenodo. 10.5281/zenodo.21837313
13. Yamagishi, Y. (2026). *The Velocity–Spacetime Curvature Duality* [Paper 63]. Zenodo. 10.5281/zenodo.21606250
14. Yamagishi, Y. (2026). *c as the Ball of Velocity Space* [Paper 60]. Zenodo. 10.5281/zenodo.21598012
15. Yamagishi, Y. (2026). *Time as a Renko Chart* [Paper 82]. Zenodo. 10.5281/zenodo.21735260
16. Yamagishi, Y. (2026). *Modules Are Not Walls but Limits* [Paper 113]. Zenodo. 10.5281/zenodo.21962996
17. Yamagishi, Y. (2026). *The Yamagishi Planck Length Unpacking Theory ($l_p = c^{-3/2}$) (3rd ed.)* [Paper 39]. Zenodo. 10.5281/zenodo.21430490
18. Yamagishi, Y. (2026). *The Yamagishi Master Table of Classical-Physics Geometric Unpacking (3rd ed.)* [Paper 38]. Zenodo. 10.5281/zenodo.21430234
19. Yamagishi, Y. (2026). *The Four Roots of Necessity* [Paper 86]. Zenodo. 10.5281/zenodo.21744839
20. Yamagishi, Y. (2026). *The Crossing of Royal Roads* [Paper 100]. Zenodo. 10.5281/zenodo.21758864

— *From thinking to syncing.* —

Yuuki YAMAGISHI (山岸 勇輝)

© 2026 Yamagishi Complexity Torus Lab, Japan · Licensed under Creative Commons Attribution 4.0 International (CC BY 4.0)