Light With Mass Had Already Been Found Inside a Superconductor

— the London penetration depth built from an electron density, **30.68** nm, and the range the same formula gives for the W boson, $\mathbf{2.4550 \times 10^{-3}}$ fm, lie $\mathbf{1.250 \times 10^{10}}$ apart, yet both return $\boldsymbol{mLc/\hbar = 1.000000000000}$ — [Paper 541]

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— *From thinking to syncing.* —

Abstract

That a force has finite range is the same statement as that its mediating particle has mass.What this paper shows is that the same relation had already been measured inside superconductors, with penetration depth and mass tied as reciprocals by one formula.No new theorem or law is claimed. First, the penetration depth follows from the electron density——53.14 nm at 1×10^{28} per cubic metre, 30.68 at 3×10^{28}, and 16.80 at 1×10^{29} (Section 2). **Second, these are of the measured order——lead at roughly 37 nm and aluminium at roughly 16 nm fall in this range** (Section 2). **Third, and this is the core.The depth can be read as a mass——$m = \hbar/(\lambda c) = 1.1465 \times 10^{-35}$ kg, or 6.4316 eV, some 1.259×10^{-5} of an electron's rest mass** (Section 3). **Fourth, the inversion returns——the depth comes back from the mass to 12 digits and the density from the depth to 10** (Section 3). **Fifth, the same formula fits the weak force——the 80.379 GeV of the W boson gives a range of 2.4550×10^{-3} fm, 1.250×10^{10} times smaller than the penetration depth** (Section 4). **Sixth, the separator is what is screening the field——$mLc/\hbar$ is 1.000000000000 in both, so the relation is one; what differs is the screen** (Section 5). **Keywords**: Meissner effect, London equations, photon mass, Anderson-Higgs mechanism, superconductivity.

Scope of this paper (scope note): **No new theorem or law is claimed——the London equations, the Meissner effect and the Anderson--Higgs mechanism are standard.Quantum field theory is not entered——no derivation of how a gauge field acquires mass; only the reciprocal relation between length and mass is examined numerically.The mechanism of superconductivity is not discussed——how pairs form is not the subject; the calculation stays inside London's phenomenology.Historical priority is not adjudicated——who noticed first is not at issue, only that the same relation occupies two places.Types of superconductor are not distinguished——the difference between type I and type II and the ratio to the coherence length are not treated.Effective mass is not used——the bare electron mass was used; in a real metal the effective mass differs.It is not asserted that "the photon acquires mass"——this is an effective description inside a medium and says nothing about the photon in vacuum.Relation to earlier papers**: **Paper 286 showed that 99.04 per cent of the proton's mass is not the Higgs——that paper divided the origins of mass; this one shows mass and length to be two readings of one quantity.Paper 175 showed that "symmetry breaking" is not one word——the breaking in a superconductor and the breaking in vacuum share a name and differ in what breaks.Paper 270 showed that the two in the flux quantum is a count of carriers——the same pairs appear there as a two and here as a penetration depth.Paper 300 showed that sharing a root is decidable——the two settings share a root under the criterion of a correspondence that preserves identity.**What is added is **building the depth from density and comparing with measured values, reading it as a mass of $\mathbf{6.4316}$ eV, confirming the inversion to 12 and 10 digits, applying the formula to the W boson for a separation of $\mathbf{1.250 \times 10^{10}}$, and placing the separator on what screens the field**.

1. Notation and the Question

Setting: **a superconductor expels magnetic field, which decays exponentially over a distance λ from the surface, the London penetration depth,**

$$\lambda = \sqrt{\frac{m}{\mu_0 \, n \, e^2}}$$

The other formula: **a force mediated by a particle of mass m_γ has range $L = \hbar/(m_\gamma c)$.**

Observation 1.1

both give a length at which a field stops reaching.One from a property of matter, the other from a particle's mass——matching shapes suggest two readings of one quantity.

Observation 1.2

there is a way to check.Read the depth as a mass and put the mass back——if it does not return, the two are different things.

Question: **is it one relation?**

2. Building the Depth from Density

Computation 2.1: **computing the depth for several densities from the electron mass and charge and the permeability of free space.**

electron density (per cubic metre)	penetration depth
1×10^{28}	**53.14** nm
3×10^{28}	**30.68** nm
1×10^{29}	**16.80** nm

Observation 2.2

these are of the measured order.Lead at roughly 37 nm, aluminium at roughly 16 nm——both fall inside the table, checking formula and inputs together. Not a claim.

Observation 2.3

it goes as the square root of density.A factor of ten from 1×10^{28} to 1×10^{29} takes 53.14 to 16.80 nm, about a 3.16th——matching $\sqrt{10} = 3.162$.

Observation 2.4

the bare electron mass was used.Real metals have a different effective mass——so agreement of order is claimed, and agreement of value is not.

3. Reading the Depth as a Mass

Computation 3.1: **putting $\lambda = 30.68$ nm into $m = \hbar/(\lambda c)$.**

quantity	value
mass	$\mathbf{1.1465 \times 10^{-35}}$ kg
energy	**6.4316** eV
ratio to the electron's rest mass	$\mathbf{1.259 \times 10^{-5}}$

> **Observation 3.2**
>
> **this is the core.Inside a superconductor the electromagnetic field behaves like a field of mass 6.4316 eV——heavy for a quantum of light, of the same order as the energy of one visible photon.**

Computation 3.3: **inverting. The depth returns from the mass to 12 digits, and the density from the depth to 10.**

> **Observation 3.4**
>
> **returning is the check.If the reading were not reversible, the two would not be one quantity——it returned, so depth and mass are two readings of one thing.**

> **Observation 3.5**
>
> **it is not said that "the photon acquires mass".This is an effective description inside a medium——nothing is claimed about the photon in vacuum, so as not to mix the two breakings that Paper 175 separated.**

4. The Same Formula for the Weak Force

Computation 4.1: **feeding the same formula the W boson mass of 80.379 GeV.**

setting	mass	length
superconductor	$\mathbf{1.1465 \times 10^{-35}}$ kg	$\mathbf{3.0681 \times 10^{-8}}$ m
W boson	$\mathbf{1.4329 \times 10^{-25}}$ kg	$\mathbf{2.4550 \times 10^{-18}}$ m
ratio of lengths	—	$\mathbf{1.250 \times 10^{10}}$

> **Observation 4.2**
>
> **ten orders apart.30.68 nm against $\mathbf{2.4550 \times 10^{-3}}$ fm——a laboratory length and a length smaller than a nucleus, entirely different worlds.**

Computation 4.3: **measuring the dimensionless $mLc/\hbar$ in both, obtaining $\mathbf{1.000000000000}$ each time.**

> **Observation 4.4**
>
> **it is one relation.Two settings ten orders apart return the same dimensionless value——by the second criterion of Paper 300 the correspondence can be written down, so this is not agreement of numbers.**

> **Observation 4.5**
>
> **the historical order follows.Measurement in superconductors preceded the understanding of the weak force——though no priority is adjudicated here; only that the relation occupies two places.**

5. The Separator

> **Observation 5.1**
>
> **the separator is what is screening the field.Electron pairs in a superconductor, another field in vacuum——one relation, different screens.**

Observation 5.2

so one of them can be removed.Warm the superconductor and the depth diverges and the mass vanishes——the vacuum does not behave so. Removability is what separates them.

Observation 5.3

the pairs of Paper 270 are at work here.There the two in the flux quantum was a count of carriers——the same pairs appear there as a two and here as a length. One object surfacing in two quantities.

Observation 5.4

the orientation differs from Paper 286.That paper divided the origins of mass——this one unites mass and length as two readings. One divides, the other binds.

Observation 5.5

what is not said.Quantum field theory is not entered——no derivation of mass generation, no mechanism of superconductivity, no distinction between type I and type II.

6. Roll Call and Closing

1. **30.68 nm at** 3×10^{28} (Computation 2.1): **between lead and aluminium.**
2. **square root of density** (Observation 2.3): **ten gives a 3.16th.**
3. **bare electron mass** (Observation 2.4): **order, not value.**
4. **mass** $\mathbf{1.1465 \times 10^{-35}}$ **kg** (Computation 3.1): **the core.**
5. **energy 6.4316 eV** (Computation 3.1): **the order of visible light.**
6. $\mathbf{1.259 \times 10^{-5}}$ **of an electron** (Computation 3.1): **heavy for light.**
7. **inversion returns to 12 and 10 digits** (Computation 3.3): **a check on reversibility.**
8. W **range** $\mathbf{2.4550 \times 10^{-3}}$ **fm** (Computation 4.1): $\mathbf{1.250 \times 10^{10}}$ **apart.**
9. $\mathbf{mLc/\hbar = 1.000000000000}$ **in both** (Computation 4.3): **one relation.**

10. **the separator is the screen** (Observation 5.1): **not the relation.**

11. **one vanishes on warming** (Observation 5.2): **removability.**

Closing: **That a force has finite range is the same statement as that its mediator has mass.The relation had already been measured inside superconductors——electron densities of 1×10^{28}, 3×10^{28} and 1×10^{29} per cubic metre give penetration depths of 53.14, 30.68 and 16.80 nm, and lead at roughly 37 nm and aluminium at roughly 16 nm fall inside. It goes as the square root of density, so a factor of ten gives about a 3.16th, matching $\sqrt{10}$. The bare electron mass was used, so agreement of order is claimed and agreement of value is not.The depth can be read as a mass——$\lambda = 30.68$ nm gives $m = \hbar/(\lambda c) = 1.1465 \times 10^{-35}$ kg, or 6.4316 eV, some 1.259×10^{-5} of an electron's rest mass, which is heavy for a quantum of light and of the order of one visible photon. The depth returns from the mass to 12 digits and the density from the depth to 10, so the reading is reversible and the two are one quantity. It is still not said that the photon acquires mass: this is an effective description inside a medium, and the two breakings separated in Paper 175 must not be mixed.The same formula fits the weak force——the 80.379 GeV of the W boson gives a range of 2.4550×10^{-18} m, that is 2.4550×10^{-3} fm, some 1.250×10^{10} times smaller than 30.68 nm. A laboratory length and a length below nuclear scale, and yet $mLc/\hbar$ returns 1.000000000000 in both. By the second criterion of Paper 300 the correspondence can be written, so this is not agreement of numbers.The separator is what screens the field——electron pairs in a superconductor, another field in vacuum: one relation with different screens. So one can be removed: warm the superconductor and the depth diverges and the mass vanishes, while the vacuum does not oblige. The pairs counted as a two in Paper 270 appear here as a length, one object surfacing in two quantities. Paper 286 divided the origins of mass; this paper binds mass and length as two readings.To be honest——quantum field theory was not entered, and no derivation of how a gauge field acquires mass was given; only the reciprocal relation between length and mass was examined. The mechanism of superconductivity was not discussed and the calculation stayed inside London's phenomenology. Type I and type II were not distinguished, the coherence length was not treated, and the bare rather than the effective electron mass was used. No priority was adjudicated. What can be said is that one relation occupies two places ten orders apart, and that one of them vanishes on warming, and no further.**

References

1. Anderson, P. W. (1963). *Plasmons, Gauge Invariance, and Mass*. Physical Review.

2. Higgs, P. W. (1964). *Broken Symmetries and the Masses of Gauge Bosons*. Physical Review Letters.

3. London, F., & London, H. (1935). *The Electromagnetic Equations of the Supraconductor*. Proceedings of the Royal Society A.

4. Meissner, W., & Ochsenfeld, R. (1933). *Ein neuer Effekt bei Eintritt der Supraleitfahigkeit*. Naturwissenschaften.

5. Yamagishi, Y. (2026). *"Symmetry Breaking" Is Not One Word* [Paper 175]. Zenodo. 10.5281/zenodo.22097873

6. Yamagishi, Y. (2026). *The Two in the Flux Quantum Is Neither a Dimension nor an Exponent but a Count of Carriers* [Paper 270]. Zenodo. 10.5281/zenodo.22169893

7. Yamagishi, Y. (2026). **99.04%** *of the Proton's Mass Is Not the Higgs* [Paper 286]. Zenodo. 10.5281/zenodo.22171199

8. Yamagishi, Y. (2026). *The Three Hundredth Census: Whether Two Things Share a Root Is Decidable* [Paper 300]. Zenodo. 10.5281/zenodo.22171914

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