

The Displacement Current Is Not a Current

— Not One Charge Crosses between the Plates, and Still a Magnetic Field Stands — The Field Computed from
Inside and from Outside Meets Exactly at the Rim — [Paper 267]

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August 2026

— *From thinking to syncing.* —

Abstract

Between the plates of a charging capacitor, not one charge crosses. And still a magnetic field stands there. This paper asks what, then, a current is—the answer is not the motion of charge. What closes Ampere's law is what has been called a current. No new mathematical theorem and no new law is claimed. First, count the charge that crosses. The conduction current in the wire is 1 A, and the charge crossing between the plates is 0 A (Section 2). Second, this is the core of the paper. The charge is zero and a field stands anyway. With plates of radius 5 cm and $I = 1$ A, the field 1 cm from the axis is $0.8000\mu\text{T}$ (Section 3). Third, the field grows in proportion to the distance from the axis. At 1, 2, 3, 4, 5 cm it is 0.8000, 1.6000, 2.4000, 3.2000, **4.0000** μT —the same form as inside a current-carrying wire (Section 3). Fourth, the two meet exactly at the rim. At $r = 5$ cm, the inside expression and the outside expression both give **4.0000** μT —the side where no charge crosses and the side where it does return the same value (Section 4). Fifth, $\epsilon_0 d\Phi_E/dt$ equals the conduction current exactly. What makes them agree is the conversion constant $\epsilon_0 = 8.8541878 \times 10^{-12}$ (Section 5). Sixth, a 4π sits here too. $\mu_0 = 4\pi \times 10^{-7} = 1.2566371 \times 10^{-6}$ —a solid angle sits inside the constant that fixes the size of the field (Section 6).

Scope of this paper (scope note): No new mathematical theorem and no new law is claimed—the Ampere-Maxwell law, the displacement current, and the field of a parallel-plate capacitor are all standard. No electromagnetism is built—what is used is one line integral and the comparison of two expressions. Maxwell's equations are not derived—Paper 93 treats the discovery of the field and Paper 116 the exponent of c . This paper receives the equations as a premise and asks only after the standing of one term. No physical medium is posited for the displacement current—neither an ether nor a polarisation of the vacuum is invoked. Only the behaviour of a term in an equation is treated. The relativistic treatment is not entered—that displacement and conduction currents exchange with the observer is mentioned but not formalised. Edge effects are not treated—the plates are taken as large with no fringing, and the numbers are values inside that idealisation. The standing of ϵ_0 is not discussed—since the SI revision of 2019, ϵ_0 is a measured quantity. This paper uses it as a conversion constant and does not make its standing a subject. The 4π in μ_0 is not called a discovery— $\mu_0 = 4\pi \times 10^{-7}$ comes from the choice of units. Paper 116 treated the non-uniqueness of 4π , and this paper follows it in writing that this one is a choice of units. Relation to earlier papers: Paper 02 showed that a pure solid angle 4π appears in an inverse-square field—Section 6 here looks at the 4π in μ_0 and writes that its standing is not the same. Paper 116 treated the non-uniqueness of 4π —this paper follows that and claims no credit for the 4π here. Paper 258 wrote the condition for 4π to appear as three items—this paper stands on the side where the condition is not met. Paper 240 counted “mass” as seven things—this paper writes that “current” does not have one meaning. Paper 201 counted “complete” as four different claims—the same shape of division. What is added is stating explicitly that the crossing charge is 0 A, computing the field between the plates at each distance, confirming that the inside and outside expressions agree at $4.0000\mu\text{T}$ on the rim, and treating the 4π of μ_0 as a choice of units and writing that its standing differs from the 4π of Paper 02.

1. Notation and Placement

Setting: charge a parallel-plate capacitor with a steady current $I = 1$ A. Take the plate radius as $R = 5$ cm.

The Ampere-Maxwell law:

$$\oint \mathbf{B} \cdot d\boldsymbol{\ell} = \mu_0 \left(I_{\text{cond}} + \epsilon_0 \frac{d\Phi_E}{dt} \right)$$

Question: the second term is called a current. What is flowing?

The answer is nothing at all. The charge crossing between the plates is 0—and still a field stands.

2. Counting the Charge That Crosses

Check 2.1: count the charge crossing per unit time at two places.

Place	Charge crossing	Name
A section of the wire	1.0 A	conduction current
A section between the plates	0.0 A	(nothing crosses)

Observation 2.2

between the plates there is vacuum. There is nothing to carry charge—it is literally zero.

Observation 2.3

here the problem arises. Span the loop of Ampere's law with a surface cutting the wire and 1 A enters; span it with a surface passing between the plates and 0 A does—one and the same loop returns two answers.

3. The Core: a Field Stands Anyway

Setting: between the plates the changing electric field supplies the second term. The field is $B = \mu_0 I r / (2\pi R^2)$ for $r < R$.

Check 3.1: with $\mu_0 = 1.2566371 \times 10^{-6}$, $I = 1$ A and $R = 0.05$ m.

Distance r from the axis	Field B
1 cm	0.8000 μT
2 cm	1.6000 μT
3 cm	2.4000 μT
4 cm	3.2000 μT
5 cm	4.0000 μT

Observation 3.2

a magnetic field stands where not one charge crosses. And it grows in proportion to r —exactly the form found inside a wire carrying a uniform current.

Observation 3.3

the separator—what has to be changed for the field to vanish. Stopping the change of the electric field. Not stopping the motion of charge—no charge was moving in the first place.

4. They Meet Exactly at the Rim

Setting: outside the plates stands the field of the conduction current, $B = \mu_0 I / (2\pi r)$. The two expressions come from different causes—inside, a changing field; outside, moving charge.

Check 4.1: evaluate both at the rim, $r = R = 5$ cm.

By which expression	Cause	Value at $r = 5$ cm
Inside, $\mu_0 I r / (2\pi R^2)$	a changing field	$4.0000 \mu\text{T}$
Outside, $\mu_0 I / (2\pi r)$	moving charge	$4.0000 \mu\text{T}$
Difference	—	0

Observation 4.2

two expressions with wholly different causes return the same value at the rim. On one side charge crosses and on the other not one does—and the field is continuous across them.

Check 4.3: set the outside alongside and see the whole shape.

r	Region	B
1 cm	between the plates	$0.8000 \mu\text{T}$
3 cm	between the plates	$2.4000 \mu\text{T}$
5 cm	the rim	$4.0000 \mu\text{T}$
10 cm	outside	$2.0000 \mu\text{T}$

Observation 4.4

it rises in proportion to r inside, peaks at the rim, and falls as $1/r$ outside. It is one smooth curve—there is no seam anywhere.

5. What a Current Is

Observation 5.1

look at the second term in numbers. Between the plates $E = \sigma/\epsilon_0 = Q/(\epsilon_0\pi R^2)$, so the flux is $\Phi_E = Q/\epsilon_0$. Hence

$$\epsilon_0 \frac{d\Phi_E}{dt} = \epsilon_0 \cdot \frac{1}{\epsilon_0} \frac{dQ}{dt} = \frac{dQ}{dt} = I$$

Observation 5.2

the ϵ_0 cancels. What remains is dQ/dt , the conduction current itself—so the two agree exactly, not approximately.

Check 5.3: read the constants that make them agree.

Constant	Value	Office
ϵ_0	8.8541878 $\times 10^{-12}$ F/m	converts field to charge
μ_0	1.2566371 $\times 10^{-6}$ H/m	converts current to field

Observation 5.4

the separator—what has to be changed for these to become different things. What one defines a current by. Define it as the motion of charge and the displacement current is not a current. Define it as what closes Ampere's law and it is. One word carries two definitions.

Observation 5.5

Paper 240 counted “mass” as seven things—this paper writes that “current” carries two definitions. The same shape.

6. The 4π inside μ_0

Observation 6.1

$\mu_0 = 4\pi \times 10^{-7} = 1.2566371 \times 10^{-6}$. A $4\pi = 12.566371$ sits inside the constant that fixes the size of the field.

Observation 6.2

a point to state honestly—its standing differs from the 4π of Paper 02. The 4π in μ_0 comes from the choice of unit system—write it in Gaussian units and μ_0 does not appear at all.

Observation 6.3

Paper 116 treated the non-uniqueness of 4π . This paper follows that and claims no credit for the 4π here—the condition Paper 258 wrote, point source, three dimensions and isotropy, is not met in this place. The solid angle is not emerging from geometry; it has been embedded in the definition of a unit.

Observation 6.4

one and the same symbol 4π carries two cases, one arising from geometry and one from units—another instance of one word carrying two standings.

7. Roll Call and Closing

1. The crossing charge is 0 (Check 2.1): 1.0 A in the wire, 0.0 A between the plates.
2. One loop, two answers (Observation 2.3): 1 A or 0 A by the surface spanned.

3. A field stands anyway(Check 3.1): $0.8000\mu\text{T}$ at $r = 1\text{ cm}$.
4. The same form as inside a wire(Observation 3.2): growing in proportion to r .
5. They meet at the rim(Check 4.1): $4.0000\mu\text{T}$ by either expression.
6. The whole is smooth(Check 4.3): rising, peaking, then falling as $1/r$.
7. The ϵ_0 cancels(Observation 5.2): leaving dQ/dt , an exact agreement.
8. Two definitions of current(Observation 5.4): motion of charge, or closing Ampere's law.
9. The 4π of μ_0 is from units(Observation 6.2): its standing differs from Paper 02's.

Closing: the displacement current was not a current. The charge crossing between the plates is 0 A , and there is nothing to carry it. Still the field stands, rising in proportion to r and reaching $4.0000\mu\text{T}$ at the rim—and computing with the outside expression, where charge does cross, returns the same $4.0000\mu\text{T}$. The ϵ_0 cancels and dQ/dt remains, so the two agree exactly and not approximately. So the word “current” carries two definitions—the motion of charge and what closes Ampere's law. And the 4π inside μ_0 likewise differs in standing from the 4π that came out of geometry—this one is embedded in the definition of a unit. One thing separates them—writing down which of the two definitions the word is being used in. Write it down, and the occasions for looking for charge separate from those for counting terms in an equation. Do not write it down, and one goes on searching for something crossing a place where nothing does.

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