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The Extended Electrodynamics Playbook

UNDERSTAND, VERIFY, AND EXPERIMENT WITH SCALAR-LONGITUDINAL WAVES

ADVANCED REDISCOVERY

Published by **Advanced Rediscovery** · The physics that textbooks skip.

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1 Why This Playbook Exists

The theory your phone runs on was simplified 140 years ago. The simplification hid an entire sector of electrodynamics. This playbook shows you what was hidden — and how to test it.

Every wireless signal you've ever sent — WiFi, Bluetooth, 5G, radio — is built on one theory. **Electrodynamics**: the physics of how electric and magnetic fields move through space and interact with matter. It's the foundation of modern electronics, communication, and energy transmission.

That theory was simplified in the 1880s. The simplification made the equations easier. It also removed physics that turns out to be real.

Extended Electrodynamics (EED) is what you get when you put the removed pieces back. Not new physics. The original physics, restored. And the restored version predicts a wave type whose potential components penetrate barriers that block all conventional signals, that carries energy through a channel no standard instrument can see, and that is invisible to every antenna design in use today.

This playbook is about what was removed, what the restored theory predicts, how to verify it, and how to test it yourself.

Before you start

This playbook is a companion to "The Deleted Degrees of Freedom" — a free research paper that makes the full argument with derivations, historical evidence, and 45+ references. The paper gives you the argument. This playbook gives you the tools. If you haven't read the paper yet, start there. It's free. This playbook assumes you know the core claim and want to go from theory to bench.

Is this legitimate? The underlying mathematics — the **Stueckelberg Lagrangian**, the master equation that defines how electromagnetic fields and their sources interact — is textbook physics. The **Aharonov-Bohm effect** — where electrons are measurably shifted by a potential in a region where no field exists — has been confirmed since 1986.

Every MRI machine on Earth operates on **potential primacy** (the principle that potentials, not fields, are the fundamental physical quantities). Four independent derivations between 2003 and 2020 recovered the same scalar field. The individual components are mainstream physics. The synthesis is new.

What this playbook covers:

- **Understand** — What was deleted, why it matters, and what the restored physics predicts (Chapters 2–3)
- **Verify** — Three binary tests that separate real scalar-longitudinal effects from marketing and wishful thinking (Chapter 4)
- **Experiment** — How to design and build a detection experiment yourself, at bench scale (Chapter 5)

Plus the questions everyone asks (Chapter 6) and the 10 papers that matter most (Chapter 7).

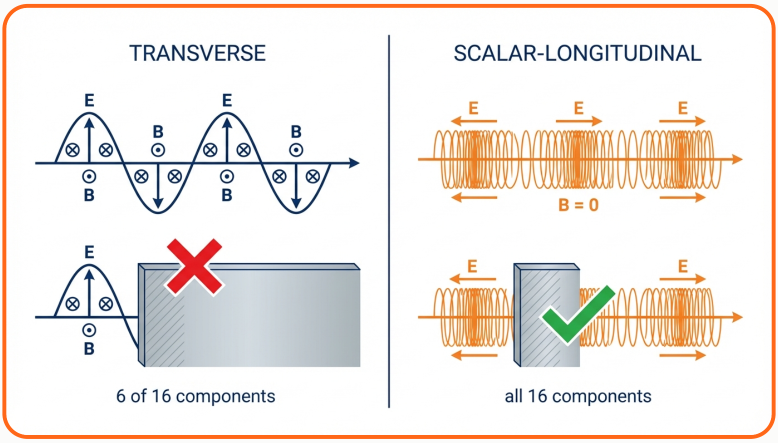

Figure 1.1: Transverse waves (left) are blocked by conductive barriers via eddy currents. Scalar-longitudinal waves (right) carry no magnetic field — the eddy-current mechanism doesn't apply, but conductors still screen the E-field via charge relaxation. The underlying potentials pass through. Same physics, different mode.

Who this is for. If you design antennas, this changes what your antenna can't see. If you build Faraday cages, this changes what gets through despite your shielding. If you test "scalar wave" devices, this gives you a protocol that separates physics from marketing in three measurements. If you're a skeptic, this gives you the equations and the experimental criteria to test the claim yourself. If you just want to understand what was removed from the theory your phone runs on — start reading.

2 What Was Deleted

Every engineering limit you know — what can be shielded, transmitted, detected — is derived from 6 numbers. Maxwell's original theory had 16. This chapter explains what happened to the other 10.

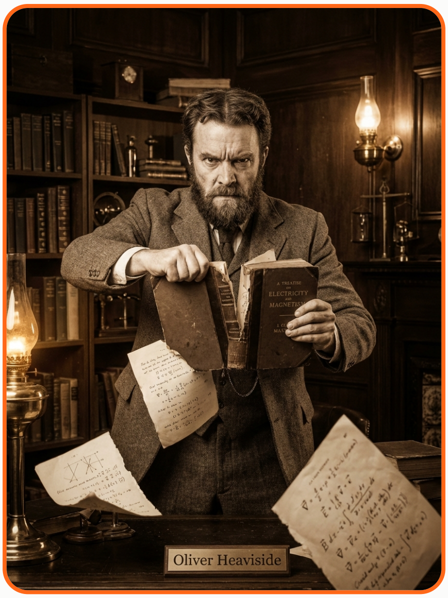

Figure 2.1: Oliver Heaviside "murdered" the potentials from Maxwell's theory. He used that word. In a letter to Oliver Lodge. While calling his own version "the real and true Maxwell."

The electromagnetic field is described by 6 numbers at every point in space: three for the **electric field** $\mathbf{E}$ (the force on a charge at rest), three for the **magnetic field** $\mathbf{B}$ (the force on a moving charge). This is what you learned in school.

Maxwell's original theory (1873) used 16.

The other 10 were removed between 1880 and 1900 in three steps. None were experimentally motivated. All removed content that turns out to have physical consequences.

The Three Deletions

1. **Heaviside's vector reduction** (1884) — Maxwell used a richer algebra (quaternions) that naturally produces two results in one operation: a scalar (single number) and a vector (direction + magnitude). Heaviside replaced it with simpler vector calculus and threw away the scalar result. Half the output of a single operation, gone.

2. **The Lorenz gauge** (enforced $\sim$1900) — A convention that sets the scalar field C to zero. Not derived from any principle. Not required by relativity. A choice, promoted to a law by the next generation of textbooks.

3. **The ontological demotion** — Potentials (ϕ, $\mathbf{A}$) were declared "merely mathematical." Fields ($\mathbf{E}$, $\mathbf{B}$) were declared "physically real." The Aharonov-Bohm effect (predicted 1959, confirmed 1986) proved this hierarchy wrong.

Each deletion seemed harmless at the time. Heaviside's equations were easier to teach. The Lorenz gauge made wave equations solvable. Declaring potentials unphysical cleaned up the ontology. But each one removed engineering degrees of freedom: a wave type that no dipole antenna can produce or detect, an energy channel that no Poynting vector can measure, and a force law that breaks Newton's third law for open circuits. The cost wasn't visible — because the instruments were designed around the simplified theory.

The equation they killed:

The Key Equation

The scalar field that the Lorenz gauge kills:

$$C = \nabla \cdot \mathbf{A} + \frac{1}{c^2}\frac{\partial \phi}{\partial t}$$

When you don't kill it, C satisfies the wave equation $\Box C = 0$ and propagates at the speed of light. It is a physical field with its own energy, its own wave equation, and its own experimental signatures.

2.1 Why Four Derivations Matter

Between 2003 and 2020, four independent derivations recovered the scalar field C:

- **Van Vlaenderen (2003)** — Split the electromagnetic potential into its independent components (a standard technique called **Helmholtz decomposition**) and showed that one component was being set to zero by convention
- **Hively & Giakos (2012)** — Four-vector analysis from scratch
- **Van Vlaenderen (2016)** — General Classical Electrodynamics (GCED), predicting three independent wave types
- **Reed & Hively (2020)** — Stueckelberg Lagrangian derivation

Four independent derivations, different starting axioms, different formalisms, same result. Woodside's uniqueness theorems (2009) explain why: the scalar-longitudinal extension is the *only* one consistent with the symmetry structure of the four-potential. They all found it because it's the only thing to find.

Independent convergence from different axioms is the signature of physical reality, not mathematical artifact. For the full argument — the historical evidence, the Stueckelberg parameter space, the convergence table — see the paper.

Where Standard Electrodynamics Sits

The Stueckelberg Lagrangian has two free parameters: γ (gauge coupling) and m (photon mass). Standard Maxwell sits at one point: $\gamma = 0, m = 0$ — two transverse polarizations, no scalar field. The Proca theory ($m > 0$) adds a third polarization via mass. EED ($\gamma = 1$, $m = 0$) adds it by promoting the Lorenz condition from a constraint to a dynamical field — no mass required. Standard textbooks teach one corner of a larger parameter space. The rest was never explored because the convention made it invisible.

The deletions were not wrong. They were incomplete — like a map that's accurate for every road it shows but is missing an entire continent. If you've only ever worked at $\gamma = 0$, you can't see what $\gamma = 1$ predicts. The next chapter shows you what's there.

3 What the Deleted Physics Predicts

Put the deleted components back and you don't get "more of the same." You get qualitatively new physics — a wave type that rewrites what "shielded" means — because shielding fields is not the same as shielding potentials.

What happens when you restore 10 missing components? You get a wave type that no existing antenna can detect, that slips past conventional shielding in the potential sector, and that no existing energy meter can measure. If it exists, it changes what "wireless" can reach and what "invisible" looks like to current instruments.

Scalar-Longitudinal Wave (SLW) — Full Specification

Electric field	Longitudinal (parallel to propagation)
Magnetic field	Zero — this is the key difference
Speed	c (no dispersion)
Attenuation	$1/r^2$ amplitude (not $1/r$ like radio)
Radiation pattern	Isotropic monopole (not dipole)
Receivable by	Monopolar antennas
Invisible to	Standard dipole antennas
Shielding	Potential sector penetrates Faraday enclosures; E-field screened by charge relaxation

Zero magnetic field changes the shielding picture. A Faraday cage blocks standard electromagnetic waves through two mechanisms: **eddy currents** (circulating currents driven by changing $\mathbf{B}$) and **charge relaxation** (free electrons redistributing to cancel any applied $\mathbf{E}$ field, in $\sim 10^{-19}$ s for copper). An SLW has no $\mathbf{B}$, so the eddy-current mechanism doesn't apply. But the longitudinal $\mathbf{E}$ field *is* still screened by charge relaxation. What a Faraday cage *cannot* screen are the underlying potentials — ϕ and $\mathbf{A}$ — because potentials don't drive charge redistribution the way fields do. The Aharonov-Bohm effect proves this: electrons respond to $\mathbf{A}$ even where $\mathbf{B} = 0$. So the potential-carried content of an SLW passes through. Detection on the other side requires potential-sensitive instruments.

Figure 3.1: The scalar-longitudinal wave carries no magnetic field. A Faraday cage screens its E-field via charge relaxation, but cannot screen the underlying potential fluctuations (ϕ, $\mathbf{A}$). A dielectric shield is the cleaner discriminator.

A standard **dipole antenna** (two rods end-to-end, like the rabbit ears on an old TV) oscillates with a transverse $\mathbf{E}$ field — perpendicular to the wave's direction of travel. An SLW's $\mathbf{E}$ field points radially, *along* the propagation direction. The dipole has a null there. Every antenna in every radio, phone, and WiFi router on Earth is blind to this mode.

A **monopole antenna** (a single vertical whip, like a car antenna) couples to radial fields. It receives the SLW mode that the dipole misses.

3.1 Where the Energy Goes

The **Poynting vector** $\mathbf{S} = \frac{1}{\mu_0}(\mathbf{E} \times \mathbf{B})$ is the standard measure of electromagnetic energy flow — it tells you how much energy passes through a given area per second. For an SLW where $\mathbf{B} = 0$, it gives **exactly zero**. The wave carries energy, but the standard accounting sees nothing.

Extended Electrodynamics (EED) — the restored 16-component theory — adds a scalar channel:

$$\mathbf{P}_{\text{EED}} = \frac{1}{\mu_0}(\mathbf{E} \times \mathbf{B}) + \frac{C}{\mu_0}\mathbf{E}$$

The $C\mathbf{E}$ term is not a small correction. For an SLW, it carries 100% of the energy. The standard Poynting vector misses all of it.

3.2 What You Could Build With This

If this mode exists, three engineering applications follow directly from its properties: no magnetic field, potential-sector propagation, and orthogonality to transverse waves.

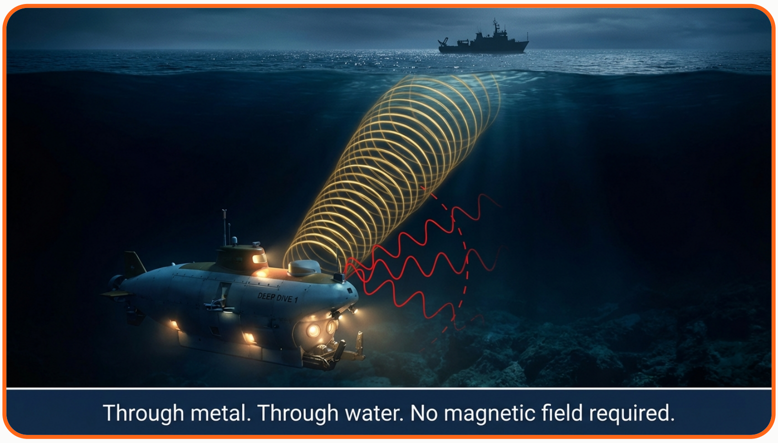

Figure 3.2: Standard radio (red) is absorbed by seawater via skin-depth attenuation. The scalar-longitudinal mode (gold) carries no magnetic field — its potential components are not subject to eddy-current losses, though the E-field component is still screened by conductive media.

Through-barrier communication. Submarines currently rely on ELF (extremely low frequency, 3–30 Hz) to receive one-way messages through seawater — at data rates measured in characters per minute. An SLW channel's potential components would penetrate water, rock, and metal without the skin-depth limitation that forces ELF to absurdly low frequencies — provided the receiver is sensitive to potentials rather than fields.

Daibo et al.'s **Vector Potential Transformer (VPT)** — a coiled coil that produces $\mathbf{A} \neq 0$ with $\mathbf{B} = 0$ in the exterior — demonstrates through-barrier signal transmission via potentials alone. Separately, Hively (US Patent 9,306,527) reports SLW transmission through Faraday enclosures with monopolar reception and $1/r^2$ attenuation.

Figure 3.3: Biological tissue is a lossy dielectric, not a conductor — the charge-relaxation screening that blocks E-fields in metals does not apply. The scalar-longitudinal mode couples to tissue through the potential gradient, offering reduced attenuation compared to standard EM-based diagnostics.

Deep-tissue sensing. Standard EM imaging (MRI, RF probing) is constrained by tissue conductivity. Biological tissue is a lossy dielectric — it lacks the free-electron density that makes metals effective E-field shields. The SLW mode couples to the scalar potential gradient, not to the magnetic field — offering a penetration mechanism with reduced attenuation compared to standard EM in tissue.

Why tissue and not metal? Copper screens E-fields via charge relaxation in $\sim 10^{-19}$ s — effectively instantaneous. Tissue doesn't have a free electron gas. Its charge relaxation is orders of magnitude slower. The mechanism that kills SLW at a copper wall barely operates in muscle, bone, or neural tissue.

Current RF diagnostics are stuck in a tradeoff: SAR (specific absorption rate) caps the power you can safely deliver, and skin depth falls off with frequency — so you choose between resolution and penetration. You can't have both. An SLW channel bypasses that tradeoff because its penetration is potential-mediated, not field-mediated. Dipole antennas can't see it. Neither can the absorption mechanisms that limit conventional imaging depth.

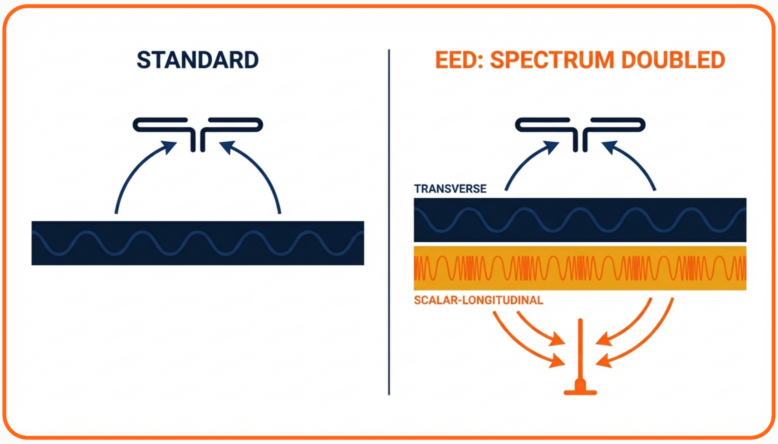

Figure 3.4: Same frequency band, two orthogonal modes. A dipole receives only transverse waves. A monopole receives only scalar-longitudinal waves. Both coexist without interference.

Spectrum doubling. Transverse and longitudinal modes are orthogonal. Both can occupy the same frequency band simultaneously. A monopolar antenna receives one, a dipole receives the other. Same spectrum, double capacity. Same principle as polarization multiplexing in fiber optics.

The US C-band auction (2021) sold RF spectrum for $81 billion. Every Hz is allocated. Spectrum scarcity drives 5G deployment costs, satellite coordination disputes, and the entire structure of wireless regulation. A second orthogonal mode in the same band doubles the usable capacity of every allocated frequency without touching a single regulatory boundary. The FCC doesn't allocate for modes it doesn't know exist.

Existing dipole infrastructure keeps working — it sees only the transverse mode it was designed for. Adding monopolar receivers and capacitively loaded sources opens the second channel. No retrofit required. The two modes don't interfere because they're geometrically orthogonal: the dipole's null is the monopole's maximum, and vice versa. Same frequency, two independent data streams, separated by antenna geometry instead of filtering.

3.3 What Sources Produce SLW

The source condition: **nonzero divergence of the current density** ($\nabla \cdot \mathbf{J} \neq 0$). Wherever charge piles up or depletes — capacitor plates, antenna tips, pulsed discharges through dielectrics, any circuit that doesn't close in a loop.

A standard dipole antenna has zero current at both ends. $\nabla \cdot \mathbf{J} = 0$ everywhere. It produces only transverse waves. That's why standard experiments never see the SLW mode — they use the one antenna geometry that *can't* produce it.

The geometry that does: a capacitively loaded monopole. Charge accumulates at the hat. $\nabla \cdot \mathbf{J} \neq 0$. The scalar field is sourced. More on this in Chapter 5.

The **toroidal geometry** is equally important. A solenoid wound into a donut shape produces $\mathbf{A} \neq 0$ outside the winding while maintaining $\mathbf{B} = 0$ in the exterior. This is the geometry behind the Aharonov-Bohm experiment, behind Daibo's VPT, and the natural starting geometry for an SLW source.

Why 140 Years of Experiments Missed This

Every standard antenna is a dipole. Every standard receiver is a dipole. Dipoles have $\nabla \cdot \mathbf{J} = 0$ everywhere — they *cannot* produce SLW. Standard experiments test the wrong source geometry with the wrong detector and conclude the mode doesn't exist. The absence of evidence is evidence of a blind spot, not evidence of absence.

What has been observed so far. NASA's Breakthrough Propulsion Physics program documented longitudinal electrostatic waves through solid glass — with *less* dispersion than through air and no magnetic field. The VPT transmits through barriers that block all standard EM. Hively's experiments report all three SLW signatures simultaneously. None have been independently replicated. That is the open problem — and the next two chapters give you the tools to change that.

4 The Three-Test Discriminator

Some "scalar wave" devices cost $120,000. Some cost $30. The physics doesn't care about the price tag. Three binary tests tell you whether any of them are real.

Figure 4.1: Left: $120,000 "scalar healing" device. Right: what a real SLW experiment looks like. Three tests separate physics from marketing.

Wellness spas, healing mats, frequency generators — the internet is full of "scalar wave" devices. Most are standard coils with a label. Here's how you tell the difference. Three binary tests. All three must pass simultaneously. No exceptions.

Test 1: Faraday Penetration

Does the signal pass through a Faraday enclosure?
Standard electromagnetic waves (TEM) are blocked by a conducting enclosure via eddy currents. SLW carry no magnetic field, so the eddy-current mechanism doesn't apply.
Pass: Signal detected inside enclosure with $B = 0$.
Fail: Signal blocked by enclosure $\rightarrow$ it's standard EM.
Caveat: Copper screens E fields via **charge relaxation** ($\sim 10^{-19}$ s) — a Faraday cage may block SLW for the wrong reason. Use a **lossy dielectric shield** (carbon foam, ferrite tiles) as a cleaner discriminator.

Test 2: Monopolar Reception

Does a monopole antenna receive it while a dipole doesn't? SLW has longitudinal $\mathbf{E}$ (radial, pointing toward the source). A monopole antenna (vertical whip) couples to this. A dipole antenna (designed for transverse $\mathbf{E}$) has a null in the longitudinal direction.
Pass: Monopole signal, dipole null (at same distance).
Fail: Both antennas receive equally $\rightarrow$ it's standard TEM.

Test 3: $1/r^2$ Attenuation

Does signal amplitude fall off as $1/r^2$, not $1/r$?
Falls off as:

- **Standard TEM:** $1/r$ amplitude, $1/r^2$ power
- **SLW:** $1/r^2$ amplitude, $1/r^4$ power
- **Near-field electrostatic:** $1/r^3$ amplitude

Pass: Power law exponent $\alpha \approx 4$ (power).
Fail: $\alpha \approx 2$ (TEM) or $\alpha \approx 6$ (electrostatic).
Requirement: At least 8 distances, logarithmically spaced, all in the far field.

4.1 The Bullshit Detector

If a manufacturer sells a "scalar wave device" and cannot demonstrate all three tests simultaneously, the "scalar" label is marketing.

Ask three questions:

1. Does your device produce $\mathbf{B} = 0$ with nonzero $\mathbf{A}$?
2. Does the signal penetrate a Faraday cage (or better, a dielectric shield)?
3. Is it receivable by a monopolar antenna?

If the answer to any of these is "I don't know" or "we haven't tested that," walk away.

Quick Reference: Real vs. Marketing

Marketing theater	Real SLW research
"Scalar energy healing"	Peer-reviewed Stueckelberg derivations
No test data, no protocol	Three-test discriminator, published methodology
Frequency generators with labels	Toroidal sources, verified $\mathbf{B} = 0$
"Ancient wisdom" claims	Ohmura 1956, Woodside 2009, Reed & Hively 2020
$120k device, zero evidence	Bench-scale experiment you build yourself

The difference between physics and marketing is a test protocol. No protocol, no science — regardless of the price tag or the website.

Red flags that should make you walk away immediately: claims of "healing frequencies" without specifying what frequency does what and why; references to "Tesla technology" without citing any specific Tesla patent, paper, or measurement; invocations of "quantum" as an adjective for a classical device; any manufacturer who refuses to let you bring a magnetometer, an oscilloscope, and a Faraday cage to the demonstration.

Green flags that suggest someone is doing real work: published source geometry with $\nabla \cdot \mathbf{J} \neq 0$, simultaneous B-field null measurement, distance sweep with power-law fit, open methodology, and willingness to share a null result. Real researchers publish nulls. Marketers don't.

5 Experiment Designs

You don't need a university lab. You need a bench, a protocol, and the willingness to publish whatever you find — positive or null.

The complete setup: a toroidal source, a Faraday cage, and a monopole antenna.[1]

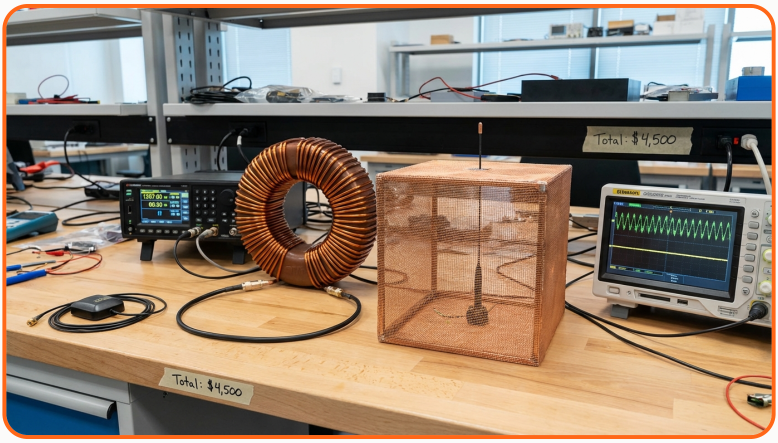

Figure 5.1: The complete C-Mode discriminator bench: toroidal source, Faraday-caged monopolar receiver, oscilloscope with E-field and B-field null channels. Bench-scale hardware — no university lab required.

5.1 The Minimum Viable Experiment

Source: Capacitively loaded monopole antenna. Vertical conductor with a disk or radial hat on top. Fed with CW at a frequency where the antenna is electrically short ($L \ll \lambda$). The hat accumulates and releases charge cyclically: $\nabla \cdot \mathbf{J} \neq 0$.

Null control: Half-wave center-fed dipole at the same frequency and power. Current goes to zero at both ends: $\nabla \cdot \mathbf{J} = 0$.

Detector: Active E-field probe (BF862 JFET source follower) + shielded loop (B-field null detector). Phase-coherent with source via GPS-disciplined oscillator.

[1] The experiment protocol here was developed in dialogue with the SLW research community — in particular Dr. Bob McGwier (N4HY), whose independent SLW detection proposal informed the apparatus design and budget estimation.

Measurement: At each distance, compare E_z from the irrotational source vs the solenoidal source. The excess, if any, is the SLW candidate. Verify $B = 0$ simultaneously.

C-Mode Discriminator – Quick Reference

Source	Capacitively loaded monopole, $L \ll \lambda$, $\nabla \cdot \mathbf{J} \neq 0$
Null control	Center-fed dipole, same freq/power, $\nabla \cdot \mathbf{J} = 0$
Detector	E-field probe (BF862 JFET) + shielded loop (B-null)
Sync	GPS-disciplined oscillator
Sweep	≥ 8 distances, logarithmic, far-field
Pass	E_z excess at 5σ, $\alpha \approx 4$, $B = 0$, dielectric penetration

5.2 What Would a Positive Result Look Like?

All of the following, simultaneously:

- E_z excess greater than zero at 5σ significance at 3+ distances
- Attenuation exponent $\alpha = 4.0 \pm 1.0$ (power)
- B-field consistent with zero at the SLW frequency
- Signal persists inside dielectric shield
- Result independent of frequency across the test band
- Replicated at a second site

5.3 What Would a Null Result Mean?

A clean null (all E_z explained by standard TEM mechanisms) places an upper bound on the SLW coupling efficiency η and constrains the Stueckelberg parameter γ. A well-documented null is as valuable as a detection. Publish it.

5.4 What Comes After Your Experiment

Whether your result is positive or null, it opens the next questions:

- **Coupling efficiency** — What fraction of input power goes into the SLW channel vs. the TEM channel? Measuring the ratio constrains the Stueckelberg parameter γ experimentally.
- **Material interaction** — How does the SLW mode behave in dielectrics, conductors, and biological tissue? EED predicts *reduced* dispersion in dielectrics — consistent with NASA observations of longitudinal electrostatic waves propagating through glass with less dispersion than through air.
- **Frequency dependence** — Does SLW generation efficiency vary across the RF spectrum? At what frequencies does the scalar channel dominate?
- **Independent replication** — One positive result is a claim. Two positive results from independent labs, with published protocols, are evidence. This is the step that changes the field. Document everything. Share your data. Your bench notes matter.

6 Frequently Asked Questions

Compiled from 80+ reader replies during the paper launch. These are real questions from engineers, physicists, and skeptics.

Foundations

Is this new physics?
No. That's the whole point. Everything was already in Maxwell's 1873 equations. Four independent derivations recovered it between 2003 and 2020 using standard mathematical tools — tensor analysis, Stueckelberg mechanism, Helmholtz decomposition. No new formalism required. No new particles. No extra dimensions. Just the components that were removed for convenience and never put back.

Isn't this fringe?
The Stueckelberg Lagrangian is in every QFT textbook. The Aharonov-Bohm effect is confirmed since 1986. Superconductors have used $\mathbf{A}$ as primary variable since the London equation (1935). Every MRI machine, every SQUID magnetometer, every particle accelerator beam pipe runs on potential primacy. The individual components are mainstream physics used daily. The synthesis — connecting them and asking "what did the deletions cost?" — is new.

What's the difference between "scalar waves" and "longitudinal waves"?
Three distinct wave types in EED: transverse (standard light and radio, $\mathbf{E}$ and $\mathbf{B}$ perpendicular to propagation), scalar-longitudinal (longitudinal $\mathbf{E}$ plus scalar field C, zero $\mathbf{B}$), and pure scalar (C only, energy without momentum). "Scalar wave" is the community's catch-all term. "Scalar-longitudinal" is the precise one. Most phenomena people discuss — Faraday penetration, VPT transmission — are the coupled scalar-longitudinal mode.

How does this connect to gravity?
Through Kaluza-Klein (1921): extend spacetime from four to five dimensions. The electromagnetic four-potential A_μ appears as off-diagonal components of the 5D metric tensor. Gauge transformations become coordinate transformations in the fifth dimension. Deleting EM degrees of freedom literally deletes gravitational degrees of freedom. The bridge between the two forces may have been sitting in the components that were thrown away.

Common Objections

Does this mean scalar waves travel faster than light?
No. The wave equation $\Box C = 0$ has c as phase velocity. Light cone respected. Tesla's 1.57c measurement was a phase velocity in the Earth-ionosphere waveguide — guided waves routinely exceed c in phase velocity. The group velocity stays at or below c. No causality violation.

Does this mean free energy?
No. EED conserves energy. The scalar channel $C\mathbf{E}$ carries energy that the standard Poynting vector can't represent, but total energy is conserved. The generalized Poynting theorem holds. What changes is the *accounting*, not the *physics*. You're not getting energy from nothing. You're measuring energy flow through a channel your instruments weren't designed to see.

But special relativity requires the Lorenz gauge, right?
No. This is the most common objection — and it's wrong. The Stueckelberg scalar transforms perfectly under Lorentz boosts. The Lorenz gauge is compatible with relativity, but not required by it. The confusion comes from the name: "Lorentz gauge" sounds like "Lorentz invariance." They're named after different physicists (Ludvig Lorenz vs Hendrik Lorentz). Jackson & Okun corrected the attribution in 2001, 134 years late.

Was this deliberately suppressed?
No. Institutional inertia, not conspiracy. Heaviside wanted simpler equations for telegraph engineering — and he got them. The problem was the next generation promoting his convenience into a truth. Textbooks copy textbooks. Professors teach what they were taught. Nobody coordinates suppression. Nobody needs to. The Lorenz/Lorentz misattribution shows how a name can be erased from the record within one generation through nothing more than careless citation.

What about Newton's third law?
The Grassmann force law (standard EM) is provably non-reciprocal for open circuits: $\mathbf{F}_{12} \neq -\mathbf{F}_{21}$ when $\nabla \cdot \mathbf{J} \neq 0$. Mathematical fact. Restoring the longitudinal Ampère force (Whittaker force law) from the scalar-longitudinal sector fixes the symmetry. Newton's third law was never broken. It was gauged away.

If this is real, why hasn't QED caught it?
Because QED tests the transverse sector. The electron magnetic moment, the Lamb shift, photon scattering — all computed from transverse photon propagators. EED and standard Maxwell make *identical* predictions for transverse phenomena. They diverge only for longitudinal configurations — the ones no standard experiment was designed to probe. QED's precision doesn't refute EED. It's silent on the question.

Is this the same as "O(3) electrodynamics"?
No. O(3) electrodynamics (Evans, AIAS group) operates in superficially similar territory — extended Maxwell, scalar waves, potential ontology — but rests on elementary group-theoretic errors: confusing $U(1)$ with $O(2)$, inverting the covering-group relation between $SU(2)$ and $SO(3)$, and a fictitious $B^{(3)}$ field refuted by experiment. The EED discussed here derives from the Stueckelberg Lagrangian, is supported by Woodside's uniqueness theorems, and has been arrived at independently by four independent derivations over two decades. Same terminology. Nothing else in common.

Practical

How do I test if a "scalar wave" device is real?
Three tests, all three simultaneously: $B = 0$ with nonzero A, Faraday/dielectric penetration, monopolar reception. See Chapter 4. If a manufacturer can't demonstrate all three, the label is marketing.

What would convince a skeptic?
Independent replication. One lab reports Faraday penetration with $B = 0$ and monopolar reception and $1/r^2$ attenuation — simultaneously, at multiple distances, with a published protocol. A second lab reproduces it with different equipment. That's the threshold. Everything before that is theory with suggestive but not conclusive experimental support. The theory is rigorous. The experiment is the open question.

Can I build something useful with this right now?
Not yet. EED is at the "verify first" stage. The three-test discriminator (Chapter 4) and the experiment design (Chapter 5) are the immediate next steps. Engineering applications — through-barrier communication, deep-tissue sensing, spectrum doubling — require confirmed detection first. The Vector Potential Transformer already works as an engineering device, but its operating principle (potential-mediated signal transmission) is still debated. Confirmation of the SLW mode would settle it. If your question isn't here, it's in the paper — free, 50 pages, 45+ references.

7 Reading List

10 papers. Ranked by "if you only read one, read this." Each annotation tells you what you'll get from it — not just what it's about.

1. **Reed & Hively (2020)** — *Symmetry* 12(12).
   Why read it: This is THE paper. The full Stueckelberg Lagrangian derivation of Extended Electrodynamics. If you want to verify every equation in this playbook, start here. It's rigorous, peer-reviewed, and gives you the Lagrangian, the field equations, the generalized Poynting theorem, and the conservation laws in one place.

2. **Wilhelm (2026)** — advanced-rediscovery.com/research
   Why read it: Connects the EED formalism to the historical deletions. Shows WHY the scalar field went missing, not just that it exists. The convergence table and the Stueckelberg parameter space diagram are the core argument. Free.

3. **Woodside (2009)** — *AJP* 77(5), 438.
   Why read it: Proves the EED decomposition is **unique**. There is exactly one way to extend EM to include the scalar-longitudinal sector. This is why four independent derivations all found the same thing — Woodside proves they had to.

4. **Osakabe et al. (1986)** — *Phys. Rev. A* 34, 815.
   Why read it: The definitive Aharonov-Bohm experiment. Electrons shifted by a potential where no field exists. Toroidal magnet inside a superconducting niobium shell. If you need one experiment to show a skeptic that potentials are physical, this is it.

5. **Rousseaux et al. (2008)** — *Eur. Phys. J. D* 49, 249.
   Why read it: The Maxwell-Lodge effect — classical Aharonov-Bohm at macroscopic scale. No quantum mechanics needed. A toroidal transformer induces a voltage in a secondary winding via $\mathbf{A}$ where $\mathbf{B} = 0$. Buildable. Reproducible. The clearest classical demonstration of potential primacy.

6. **Van Vlaenderen (2003)** — *Hadronic Journal* 24.
Why read it: The first modern derivation. Uses Helmholtz decomposition — mathematically clean and self-contained. If you want to derive C yourself from first principles, this is the shortest path.

7. **Ohmura (1956)** — *Prog. Theor. Phys.* 16(6), 684.
Why read it: The earliest known formulation of the scalar field. 1956. Predates everyone else by nearly half a century. If someone tells you this is "new" or "unproven," point them here.

8. **Goto (1967)** — *Prog. Theor. Phys.* 37, 571.
Why read it: Shows that longitudinal and scalar photons persist as dynamical variables in QFT. Gupta-Bleuler removes them by convention, not by necessity. If someone says "QED only has 2 polarizations," Goto is the answer.

9. **Konopinski (1978)** — *AJP* 46, 499.
Why read it: Makes the case that the vector potential carries physical field momentum. Published in the American Journal of Physics — not a fringe journal. Changes how you think about $\mathbf{A}$ as a physical entity.

10. **Minotti & Modanese (2023)** — *Symmetry* 15(5), 1119.
Why read it: Extends the scalar field into material media. Shows how C behaves in conductors, dielectrics, and plasmas. Essential if you're designing experiments with real materials, not vacuum.

This playbook is a companion to "The Deleted Degrees of Freedom" by Dr. Paul Wilhelm (2026). It distills the paper's arguments into an actionable field guide for engineers and experimentalists.

The paper is free. The research continues. Subscribe for the next one.

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