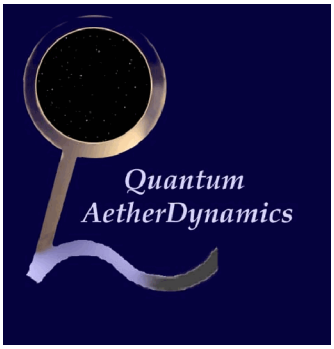

Quantum AetherDynamics Institute (QADI)

Quantifying Longitudinal Waves in the Aether Physics Model: Pulse-Driven Scalar-Wave Accounting and Acoustic-Electric Benchmarks

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It develops the Aether Physics Model (APM)

Abstract

This paper introduces an Aether Physics Model (APM) quantification layer for longitudinal (scalar) wave transport that is explicitly compatible with Quantum Measurement Units (QMU). The central move is to treat pulse-driven longitudinal phenomena through a mixed-derivative operator whose natural unit is the QMU scalar-wave primitive sclw := F_q/λ_C. This choice ties longitudinal excitation to a ledger-scaled conversion between temporal oscillation and spatial compression, and makes short, high-potential impulses a first-class driving primitive. A concrete engineering benchmark is provided by wireless acoustic-electric feed-through (WAEF) devices, which transfer power through a solid wall using stress waves. We recast the WAEF transfer problem into QMU using energy and power primitives enrg and powr (with powr interpreted as power and enrg as energy), and we propose pulse-domain experimental gates that distinguish resonance capture from longitudinal transport. The narrative also links the scalar-wave bookkeeping to the Maxwell (1864) twenty-equation ledger via dual-potential definitions and the longitudinal Ampère–Maxwell time-derivative structure.

Contents

1 Ledger framing and QMU primitives **2**

1.1 Ledger One as the propagation anchor . . . 2

1.2 Energy and power in QMU . . . 2

2 Defining the scalar-wave primitive sclw **3**

2.1 Scalar-wave unit . . . 3

2.2 Mixed-derivative operator . . . 3

2.3 Geometry-defined gradients and the λ_C scaling . . . 3

2.4 Mixed-derivative scalar-wave amplitudes (normalized) . . . 3

2.5 Piezoelectric transduction constant linking sclw_u^* and sclw_ϕ^* . . . 4

2.6 Relation to dispersion bookkeeping . . . 4

3 Embedding sclw **in the Maxwell (1864) twenty-equation ledger** **5**

4 Longitudinal energy flux in QMU **5**

4.1 Mechanical longitudinal channel . . . 5

4.2 Pulse accounting via scalar-wave activity . . . 5

5 Benchmark: acoustic-electric feed-through as a longitudinal transfer device **6**

5.1 WAEF as an engineered longitudinal converter . . . 6

5.2 Equivalent-circuit viewpoint in QMU . . . 6

5.3 Pulse-domain translation . . . 6

6 Tesla impulse narrative as scalar-wave driving **7**

6.1 Short, high-potential impulses as the driving primitive 7

6.2 One-wire and earth-coupled transmission as longitudinal channels 7

7 Proposed experiments and falsifiable gates **7**

7.1 Gate A: scalar-wave activity scaling at fixed energy budget 7

7.2 Gate B: resonance capture versus longitudinal transport 8

7.3 Gate C: spatial-gradient localization 8

8 Discussion: why WAEF is the right starting point **8**

9 Conclusion **9**

1 Ledger framing and QMU primitives

1.1 Ledger One as the propagation anchor

APM Ledger One is the Aether rotational self-identity

$$A_u \cdot \mathrm{curl} \;=\; {F_q}^2 {\lambda_C}^2, \tag{1}$$

with the mainstream anchor $F_q \lambda_C = c$, yielding $A_u \cdot \mathrm{curl} = c^2$. This paper uses Ledger One as the propagation normalization: when a longitudinal channel is introduced (mechanical, electrostatic, or hybrid), its effective transport parameters are expressed as ratios against the baseline F_q and λ_C scales rather than by introducing external units.

1.2 Energy and power in QMU

In this paper,

$$\mathrm{enrg} \;:=\; m_\mathrm{e}(F_q\lambda_C)^2 \;=\; m_\mathrm{e}{F_q}^2{\lambda_C}^2, \qquad \mathrm{powr} \;:=\; \mathrm{enrg}\, F_q \;=\; m_\mathrm{e}{F_q}^3{\lambda_C}^2. \tag{2}$$

These are ledger-consistent in the sense that enrg is the kinetic energy scale associated with m_e and the photon-speed primitive $F_q\lambda_C$, and powr is the corresponding energy-throughput scale per quantum time $1/F_q$.

A useful derived quantity for longitudinal transport is the QMU pressure scale (energy density)

$$\mathrm{pres} \;:=\; \frac{\mathrm{enrg}}{\mathrm{volm}} \;=\; \frac{m_\mathrm{e}{F_q}^2{\lambda_C}^2}{{\lambda_C}^3} \;=\; \frac{m_\mathrm{e}{F_q}^2}{\lambda_C}. \tag{3}$$

Thus longitudinal stress-wave energetics can be carried without introducing any auxiliary base unit: pressure is simply enrg/volm in QMU.

2 Defining the scalar-wave primitive sclw

2.1 Scalar-wave unit

We define the QMU scalar-wave primitive as

$$\text{sclw} \;:=\; \frac{F_q}{\lambda_C}. \tag{4}$$

This quantity has the character of a mixed temporal-spatial rate and naturally appears when a longitudinal excitation is treated as a compression-rate field rather than as a purely temporal oscillation or purely spatial strain.

Two immediate identities are often useful:

$$\text{sclw}\,\lambda_C \;=\; F_q, \qquad \text{sclw}\,{\lambda_C}^2 \;=\; F_q\lambda_C \;=\; c. \tag{5}$$

Thus sclw can be read as "propagation speed per quantum area," which is the conversion needed when a scalar potential pulse couples to a longitudinal gradient along a conductor or along a mechanical axis.

2.2 Mixed-derivative operator

Define the mixed-derivative operator

$$\mathcal{S} \;:=\; \frac{\partial^2}{\partial t\,\partial x}. \tag{6}$$

2.3 Geometry-defined gradients and the λ_C scaling

The operator $\mathcal{S} = \partial_t\partial_x$ is only meaningful once the effective longitudinal gradient scale is fixed. In practice, the relevant spatial derivative is set by an electrode or transducer-face geometry length ℓ_{eff} (field-focusing and edge concentration), not by the bulk size of the apparatus. Define the dimensionless geometry factor

$$g_{\text{geom}} \;:=\; \frac{\ell_{\text{eff}}}{\lambda_C}, \qquad \partial_x \sim \frac{1}{\ell_{\text{eff}}} \;=\; \frac{1}{g_{\text{geom}}\,\lambda_C}. \tag{7}$$

Thus, at fixed drive waveform, scalar-wave activity increases as g_{geom} decreases (sharper geometry-defined gradients). This is the QMU statement that "sharpness" is a pure number controlled by geometry relative to λ_C.

2.4 Mixed-derivative scalar-wave amplitudes (normalized)

The scalar-wave primitive is $\text{sclw} = F_q/\lambda_C$, so $\text{sclw}\,\lambda_C = F_q$.

Mechanical longitudinal channel. Let $u(x,t)$ be longitudinal displacement and $\varepsilon := \partial_x u$ the strain. Define the normalized scalar-wave amplitude

$$\mathrm{sclw}_u^* \;:=\; \frac{1}{F_q}\,\partial_t \varepsilon \;=\; \frac{1}{\mathrm{sclw}\,\lambda_C}\,\mathcal{S}u. \tag{8}$$

This is dimensionless because ε is dimensionless.

Electrical scalar-potential channel. Let $\phi_e(x,t)$ be the electric scalar potential. In QMU, a natural scalar-potential scale is energy per electrostatic charge:

$$\varphi_q \;:=\; \frac{\mathrm{enrg}}{e^2}. \tag{9}$$

Define the normalized scalar-wave amplitude

$$\mathrm{sclw}_\phi^* \;:=\; \frac{\lambda_C}{F_q\,\varphi_q}\,\mathcal{S}\phi_e \;=\; \frac{e^2}{\mathrm{enrg}}\,\frac{\lambda_C}{F_q}\,\partial_t\partial_x\phi_e, \tag{10}$$

which is also dimensionless.

2.5 Piezoelectric transduction constant linking sclw_u^* and sclw_ϕ^*

Within the active piezoelectric layer (after electrode averaging), adopt a 1D constitutive closure

$$E_\parallel \;\approx\; \kappa_{\mathrm{pz}}\,\varepsilon, \qquad E_\parallel := -\partial_x\phi_e, \tag{11}$$

where κ_{pz} is an effective (geometry-averaged) transduction coefficient. Taking ∂_t and using Eqs. (8) and (10) yields

$$\mathrm{sclw}_\phi^* \;=\; -\Xi_{\mathrm{pz}}\,\mathrm{sclw}_u^*, \qquad \Xi_{\mathrm{pz}} \;:=\; \frac{\lambda_C\,\kappa_{\mathrm{pz}}}{\varphi_q}. \tag{12}$$

The constant Ξ_{pz} is dimensionless in QMU and captures both material coefficients and electrode-defined field concentration. Operationally, Ξ_{pz} is the calibration parameter that relates measured mixed-derivative potential features to strain-rate features inside the piezoelectric layer.

2.6 Relation to dispersion bookkeeping

For a monochromatic longitudinal wave $u \propto e^{i(kx-\omega t)}$,

$$\mathcal{S}u \;=\; (-i\omega)(ik)\,u \;=\; \omega k\,u, \tag{13}$$

and therefore the spectral scalar-wave density is naturally

$$\mathrm{sclw}_{\omega k} \;:=\; \omega k, \qquad \mathrm{sclw}_{\omega k}^* \;:=\; \frac{\omega k}{F_q/\lambda_C} \;=\; \left(\frac{\omega}{F_q}\right)(k\lambda_C). \tag{14}$$

This provides a convenient diagnostic for whether a measured longitudinal channel behaves like a conventional dispersive waveguide (where ω and k are tied by a medium speed) or like a pulse-driven scalar-wave transport channel where mixed derivatives are the primary coupling descriptors.

3 Embedding sclw in the Maxwell (1864) twenty-equation ledger

In the Maxwell (1864) QMU ledger formulation using dual potentials Thomson III [2025b], the electric field is defined by

$$\mathbf{E} \;=\; -\nabla\phi_e \;-\; \partial_t \mathbf{A}_e \;-\; \nabla \times \mathbf{A}_m, \tag{15}$$

with propagation fixed by the ledger speed closure $c = \lambda_C F_q$.

For a chosen longitudinal direction $\hat{\mathbf{n}}$, the longitudinal component is

$$E_{\parallel} \;:=\; \hat{\mathbf{n}} \cdot \mathbf{E} \;=\; -\partial_{\parallel}\phi_e \;-\; \partial_t A_{e,\parallel} \;-\; \hat{\mathbf{n}} \cdot (\nabla \times \mathbf{A}_m). \tag{16}$$

Therefore the scalar-wave mixed derivative satisfies

$$\mathcal{S}\phi_e \;=\; \partial_t \partial_{\parallel}\phi_e \;=\; -\partial_t E_{\parallel} \;-\; \partial_t^2 A_{e,\parallel} \;-\; \partial_t\, \hat{\mathbf{n}} \cdot (\nabla \times \mathbf{A}_m). \tag{17}$$

In the quasi-longitudinal regime (or after accounting for the correction terms explicitly), $\mathcal{S}\phi_e$ is the QMU-native bookkeeping object for the longitudinal Ampère–Maxwell time-derivative term $\partial_t E_{\parallel}$. In this sense, sclw^*_ϕ packages the longitudinal time-varying electric response in a single dimensionless observable that is compatible with both the Maxwell ledger and the pulse-domain longitudinal-wave narrative developed here.

4 Longitudinal energy flux in QMU

4.1 Mechanical longitudinal channel

In a 1D elastic channel, a standard energy-flux proxy is the product of longitudinal stress p_L and particle velocity v_p:

$$\mathcal{J}_L \;\sim\; p_L\, v_p. \tag{18}$$

In QMU scaling, write

$$p_L \;=\; p_L^*\,\mathrm{pres}, \qquad v_p \;=\; v_p^*\,(F_q \lambda_C). \tag{19}$$

Then the flux scale is

$$\mathcal{J}_L \;\sim\; (p_L^* v_p^*)\,\mathrm{pres}(F_q\lambda_C) \;=\; (p_L^* v_p^*)\,\frac{\mathrm{enrg}}{\mathrm{volm}}(F_q\lambda_C) \;=\; (p_L^* v_p^*)\,\frac{\mathrm{powr}}{{\lambda_C}^2}. \tag{20}$$

This identifies a clean ledger statement: longitudinal flux is naturally power per quantum area.

4.2 Pulse accounting via scalar-wave activity

For pulse-driven experiments, the instantaneous mixed-derivative amplitudes $\mathcal{S}u$ and $\mathcal{S}\phi_e$ quantify how quickly a longitudinal gradient is established. A practical gate is to measure a scalar-wave activity functional. Using dimensionless time $t^* := F_q t$ and dimensionless coordinate $x^* := x/\lambda_C$, define

$$\mathcal{A}_{\mathrm{sclw}} \;:=\; \int_{t_0^*}^{t_1^*}\!\!\int_{x_0^*}^{x_1^*} \left(\mathrm{sclw}_u^*\right)^2 dt^*\, dx^* \qquad \text{or} \qquad \mathcal{A}_{\mathrm{sclw}} \;:=\; \int_{t_0^*}^{t_1^*}\!\!\int_{x_0^*}^{x_1^*} \left(\mathrm{sclw}_\phi^*\right)^2 dt^*\, dx^*, \tag{21}$$

depending on which channel is directly instrumented. Large $\mathcal{A}_{\mathrm{sclw}}$ indicates operation in a regime where extremely short, high-gradient pulses do nontrivial longitudinal work, regardless of whether the channel is mechanical, electrostatic, or hybrid.

5 Benchmark: acoustic-electric feed-through as a longitudinal transfer device

5.1 WAEF as an engineered longitudinal converter

Wireless acoustic-electric feed-through (WAEF) devices transfer electrical power through a solid barrier by converting electrical drive into longitudinal stress waves (indirect piezoelectric effect), transmitting through the wall, and reconverting stress waves back into electrical output (direct piezoelectric effect). A high-power demonstration is reported by Sherrit *et al.* [Sherrit et al., 2008] building on earlier theoretical and experimental formulations [Hu et al., 2003].

From an APM/QMU perspective, WAEF is valuable because it is unambiguously longitudinal: the wall-coupled channel is a stress-wave channel, so the experiment supplies an operational reference for what a longitudinal transport device looks like when the transport is indisputably mechanical.

5.2 Equivalent-circuit viewpoint in QMU

Let the electrical input port be characterized by an effective complex impedance $Z_{\text{in}}(\omega)$ and the load by $Z_L(\omega)$. Define the transfer efficiency

$$\eta(\omega) \;:=\; \frac{\text{powr}_{\text{out}}(\omega)}{\text{powr}_{\text{in}}(\omega)}. \tag{22}$$

In QMU we write

$$\text{powr}_{\text{in}}(\omega) \;=\; \text{powr}\,\text{powr}^{*}_{\text{in}}(\omega), \qquad \text{powr}_{\text{out}}(\omega) \;=\; \text{powr}\,\text{powr}^{*}_{\text{out}}(\omega), \tag{23}$$

so $\eta(\omega) = \text{powr}^{*}_{\text{out}}/\text{powr}^{*}_{\text{in}}$ is dimensionless and ledger-clean.

The WAEF literature emphasizes that multiple longitudinal resonances exist and that efficiency peaks align with resonance peaks [Sherrit et al., 2008]. In APM language, this is a concrete instance of longitudinal capture: the device stores and exchanges energy through a wall-coupled longitudinal mode, and the electrical ports are transducers onto that mode.

5.3 Pulse-domain translation

A pulse drive $V(t)$ has a broad spectrum $\tilde{V}(\omega)$, so the output depends on how the pulse spectrum overlaps the longitudinal resonance ladder. The APM scalar-wave primitive suggests measuring not only η but also the scalar-wave activity $\mathcal{A}_{\text{sclw}}$ from Eq. (21) as an independent control variable.

Operational hypothesis:

> At fixed delivered energy per pulse (fixed enrg budget), increasing $\mathcal{A}_{\text{sclw}}$ by shortening the pulse and steepening the longitudinal gradient increases the fraction of energy that couples into longitudinal modes relative to non-longitudinal loss channels.

WAEF devices provide a controlled testbed for this claim because the longitudinal wall mode is directly engineered and instrumentable.

6 Tesla impulse narrative as scalar-wave driving

6.1 Short, high-potential impulses as the driving primitive

Tesla emphasized the operational importance of condenser energy discharged in an extremely short interval of time, describing the resulting increase in "activity" as a practical route to strong effects [Tesla, 1994]. In APM/QMU bookkeeping, this is interpreted as a strategy for maximizing scalar-wave activity: short duration implies large temporal gradients, and high potential implies large longitudinal gradients along the available conduction geometry.

In the scalar-wave notation of Eqs. (10) and (17), a Tesla-style impulse drive aims to maximize $|\mathcal{S}\phi_e|$ and therefore to maximize $|\mathrm{sclw}^*_\phi|$. In the mechanical analog (e.g., a wall-coupled longitudinal mode), the corresponding objective is to maximize $|\partial_t \varepsilon|$ and therefore $|\mathrm{sclw}^*_u|$.

6.2 One-wire and earth-coupled transmission as longitudinal channels

Tesla also contrasts radiated electromagnetic waves with current-wave transmission through the earth and treats the latter as recoverable energy in an "elastic system" [Tesla, 1994]. For APM purposes, this provides a narrative bridge:

- The recoverable channel corresponds to a longitudinal degree of freedom (compression/rarefaction of the transmission medium).
- The operational knob is pulse design, which in QMU is captured by $\mathcal{A}_{\mathrm{sclw}}$ and by geometry-defined gradients via g_{geom}.

This does not require identifying the medium *a priori* as mechanical or electrical; it requires only that the measured channel respond primarily to longitudinal gradients and that the effective transport can be parameterized by scalar-wave activity rather than by transverse radiation metrics.

7 Proposed experiments and falsifiable gates

7.1 Gate A: scalar-wave activity scaling at fixed energy budget

Construct a pulse generator that can vary pulse width and rise time while holding the per-pulse energy fixed:

$$\int_{t_0}^{t_1} V(t) I(t)\, dt \;=\; \mathrm{enrg}_{\mathrm{pulse}} \;=\; \mathrm{enrg}\,\mathrm{enrg}^*_{\mathrm{pulse}} \quad \text{(fixed)}. \tag{24}$$

Measure output in a longitudinal receiver (mechanical WAEF receiver or an electrical longitudinal probe) and compute

$$G_A \;:=\; \frac{\mathrm{powr}^*_{\mathrm{out}}}{\mathrm{enrg}^*_{\mathrm{pulse}}} \quad \text{as a function of} \quad \mathcal{A}_{\mathrm{sclw}} \;\text{ and }\; g_{\mathrm{geom}}. \tag{25}$$

Prediction (APM scalar-wave hypothesis): G_A increases monotonically with $\mathcal{A}_{\mathrm{sclw}}$ over the regime where longitudinal coupling dominates, and improves as g_{geom} decreases (sharper geometry-defined gradients).

Failure mode: G_A is independent of $\mathcal{A}_{\mathrm{sclw}}$ once the energy budget is fixed, indicating that pulse sharpness does not preferentially enhance longitudinal capture.

7.2 Gate B: resonance capture versus longitudinal transport

In a WAEF-like structure, tune the longitudinal resonance ladder (by varying backing masses, preload, or wall boundary conditions) while keeping the electrical pulse generator unchanged. Define

$$G_B \;:=\; \frac{\mathrm{powr}^{*}_{\mathrm{out}}}{\mathrm{powr}^{*}_{\mathrm{in}}}, \qquad G_B^{(\mathrm{CW})} \;:=\; \max_{\omega}\eta(\omega), \qquad G_B^{(\mathrm{pulse})} \;:=\; \eta_{\mathrm{pulse}}. \tag{26}$$

If the observed transfer is dominated by resonance capture, then $G_B^{(\mathrm{pulse})}$ should track the resonance retuning similarly to $G_B^{(\mathrm{CW})}$. If instead the transfer is dominated by a longitudinal scalar-wave transport channel that is not resonance-limited, then $G_B^{(\mathrm{pulse})}$ should be comparatively insensitive to modest resonance retuning, provided $\mathcal{A}_{\mathrm{sclw}}$ is held high.

7.3 Gate C: spatial-gradient localization

Because sclw is explicitly tied to longitudinal gradients, a decisive test is spatial localization:

$$\mathrm{sclw}^{*}_{\phi}(x,t) \;=\; \frac{\lambda_C}{F_q\,\varphi_q}\,\partial_t\partial_x\phi_e. \tag{27}$$

Instrument $\partial_x\phi_e$ (or an equivalent longitudinal field proxy) at multiple positions along the transmission geometry. A longitudinal channel predicts coherent propagation of sclw^{*}_{ϕ} features; a purely local discharge with stray coupling predicts rapid decorrelation with distance.

8 Discussion: why WAEF is the right starting point

The WAEF benchmark provides three practical advantages for APM longitudinal-wave quantification:

1. It is an engineered longitudinal converter with strong, repeatable coupling.
2. It supplies an operational efficiency metric without ambiguity about the transport channel.
3. It supports both CW (spectrally narrow) and pulse (spectrally broad) drive, enabling scalar-wave activity gates in a controlled setting.

In particular, WAEF results demonstrate that significant wall-throughput can be achieved in a narrowband longitudinal regime [Sherrit et al., 2008], which makes WAEF a natural calibration device for separating "energy moved through a longitudinal mode" from "energy lost to non-longitudinal channels."

The APM addition is not to reinterpret WAEF as something else; it is to use WAEF as a validated longitudinal platform and then to port Tesla-style impulse strategies into that platform using the scalar-wave primitive $\mathrm{sclw} = F_q/\lambda_C$ and its normalized activity functionals as the bookkeeping variables that measure what the impulse is doing to longitudinal gradients. The explicit coupling constant Ξ_{pz} in Eq. (12) then provides the formal bridge between mixed-derivative electrical observables and mixed-derivative mechanical observables in the piezoelectric transducer itself.

9 Conclusion

We introduced a QMU-native scalar-wave primitive sclw := F_q/λ_C and used it to define mixed-derivative, pulse-domain longitudinal amplitudes that are dimensionless and ledger-compatible. The refinement additions formalize (i) the geometry dependence of longitudinal gradients via the pure number $g_{\text{geom}} = \ell_{\text{eff}}/\lambda_C$ and (ii) the piezoelectric coupling of mixed-derivative mechanical and electrical channels via the QMU transduction constant Ξ_{pz}. We also tied $\mathcal{S}\phi_e$ directly to the longitudinal Ampère–Maxwell time-derivative structure in the Maxwell (1864) twenty-equation ledger, showing how sclw^*_ϕ functions as a ledger-consistent longitudinal bookkeeping observable. Wireless acoustic-electric feed-through devices provide an unambiguous longitudinal benchmark and a practical engineering platform for falsifiable gates that distinguish resonance capture from longitudinal transport. The next step is to implement Gates A–C on a WAEF-like fixture driven by a controllable impulse generator, and to report the $\mathcal{A}_{\text{sclw}}$ and g_{geom} scaling of longitudinal transfer under fixed enrg budgets.

Acknowledgments

The Quantum AetherDynamics Institute (QADI) is a private 501(c)(3) research institute developing the Aether Physics Model (APM) and Quantum Measurement Units (QMU). Thomson III [2025a] Publications and data are archived with DOIs in the AetherPhysics Zenodo community: zenodo.org/communities/aetherphysics.

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