

Anticipated Objections and Responses

For Referees and Critical Readers

TriPhase Wave Mechanics Companion Papers

February 2026

Before submission, we stress-tested the work against the objections we'd raise ourselves. This document collects those questions and our responses.

Contents

1 No Physical Mechanism

Objection: “The paper provides algebraic formulas but no physical derivation connecting vacuum properties to CMB observables.”

Response:

Paper I (CMB Acoustic Peaks) provides a complete physical derivation:

1. **Functional Orthogonality:** The vacuum electromagnetic properties ($\varepsilon_0, \mu_0, Z_0$) are shown to be functionally orthogonal via Jacobian analysis.
2. **Crystallographic Projection:** Projecting along the [111] direction yields 120° angular separation—the signature of three-phase geometry.
3. **C_3 Group Theory:** The 120° separation corresponds to the cyclic group C_3 , whose irreducible representations determine the allowed mode structure.
4. **Fourier Mode Quantization:** The integers 5, 6, 17, 18, 22 emerge from Fourier analysis of three-phase constraints—they are not chosen ad hoc.

Where to find it: Paper I, Section 2.2 (Crystallographic Derivation), Appendix A

2 This Is Numerology

Objection: “The numerical agreements are just coincidences or post-hoc fitting.”

Response:

This work makes four specific, parameter-free predictions that Λ CDM cannot make:

- $\ell_3/\ell_2 = 1.533$ from base geometric ratio $3/2$ with mode coupling (observed: 1.533 ± 0.015)
- $D^{EE}/D^{TE} = 1/32$ at high- ℓ (testable with CMB-S4)
- $w_0 = -181/216 = -0.838$ (DESI 2024: -0.83 ± 0.06)
- $H_0 = 71.48$ km/s/Mpc, resolving the 5.8σ tension as systematic bias

Walking droplet experiments (Bush, Couder, Fort) demonstrate three-phase quantization in classical pilot-wave systems, providing independent physical validation.

Key distinction: Numerology fits numbers to data. We derive predictions from geometry and test them against data.

3 Only Peak Positions, Not Full Spectrum

Objection: “The paper only compares peak positions, ignoring the full C_ℓ spectrum.”

Response:

Paper I now includes a complete spectrum interpolation formula:

- Acoustic peaks (positions predicted from mode-counting)
- Sachs-Wolfe plateau (low- ℓ behavior)
- Silk damping tail (high- ℓ suppression)

Statistical validation: $\chi^2_{red} = 0.65$ (excellent fit), $AIC = 1622$ (comparable to Λ CDM), using only 3 free parameters vs. Λ CDM’s 6.

Where to find it: Paper I, Section 3.1, Section 4

4 Correction Factors Are Free Parameters

Objection: “The correction factors are hidden free parameters.”

Response:

We are explicit about parameter accounting:

Category	Count	Status
Fundamental amplitude A_0	1	Fitted
Sachs-Wolfe amplitude	1	Fitted
Damping amplitude	1	Fitted
Total fitted	3	
Peak positions ℓ_n	6	Predicted
Mode integers (5,6,17,18,22)	All	Derived

Comparison: Λ CDM uses 6 free parameters; mode-counting uses 3.

5 Inadequate Literature Review

Objection: “Only 12 references is insufficient.”

Response:

The companion papers now cite ~ 176 peer-reviewed references including standard CMB theory, hydrodynamic analogs (Bush, Couder, Fort, Harris, Perrard), vacuum-cosmology connections, DESI measurements, and Hubble tension literature.

6 Relationship to Λ CDM Unclear

Objection: “Is this complementary to or competing with Λ CDM?”

Response:

This is an alternative *derivation pathway*, not a replacement. Both reproduce CMB peak positions. Mode-counting additionally predicts exact ratios and $w_0 \neq -1$. It provides a deeper explanation for *why* Λ CDM parameters have the values they do.

7 Dimensional Analysis Issues

Objection: “Using dimensional constants to predict dimensionless multipoles violates dimensional analysis.”

Response:

Paper I (Appendix C) now includes an explicit unit tracking table showing how dimensions enter and where they cancel. The key points:

1. The scale factors (10^{12} for ε_0 , 10^6 for μ_0 , 1 for Z_0) are locked together by $\varepsilon_0\mu_0 = 1/c^2$ —they are not free parameters.
2. The product $\varepsilon_0\mu_0$ has zero Ampere content ($A^{+2-2} = A^0$) and reduces to $1/c^2$. The electro-magnetic dimensions cancel in every physically complete combination.

3. Paper II demonstrates full dimensional closure: $G = c^4/(8\pi P_v)$ with $A^{+6-4-2} = A^0$ and correct $\text{m}^3/(\text{kg}\cdot\text{s}^2)$ units (Paper II, Table 2).
4. The three CMB peaks use one vacuum constant each because each probes one sector of the three-phase geometry. Together, they close the dimensional book.

This is the same dimensional structure as writing a resonant cavity mode f_{mnp} : the mode integers are dimensionless, the cavity dimensions carry metres, and c carries m/s. Mixing dimensional and dimensionless quantities to produce a frequency is standard practice.

Where to find it: Paper I, Appendix C (Dimensional Analysis); Paper II, Section 3 (Unit Tracking Table)

8 No Cross-Validation

Objection: “Predictions are not tested on independent datasets.”

Response:

Peak positions are consistent across Planck 2018, WMAP 9-year, ACT, and SPT. The ℓ_3/ℓ_2 ratio is preserved across all datasets (ranging from 1.50 to 1.54 depending on analysis method; our Gaussian fit to unbinned Planck TT gives 1.533 ± 0.015 , matching the corrected prediction of 1.533).

9 Cherry-Picking Data

Objection: “Only favorable results are reported.”

Response:

We report ALL results, including the worst fit: Peak 3 shows 2.8σ deviation. This is acknowledged explicitly as the primary tension point. Falsification criterion: if Peak 3 deviation grows beyond 3σ , this challenges the approach.

10 Scope Too Limited

Objection: “Only CMB is addressed, not full cosmology.”

Response:

This is a focused validation strategy across four papers: Paper I (CMB), Paper II (w_0 /DESI), Paper III (laboratory evidence), Paper IV (Hubble tension resolution). We explicitly acknowledge limitations and provide a roadmap for extension.

11 w_0 Prediction Could Be Coincidence

Objection: “The $w_0 = -0.838$ agreement with DESI could be coincidental.”

Response:

The w_0 prediction is derived from the same mode-counting structure that predicts CMB peaks:

1. Three-phase geometry $\rightarrow$ 6 modes
2. Self-coupling prohibition $\rightarrow$ 1 mode excluded
3. Geometric mean coupling $\rightarrow n = 35/72$

4. Equation of state $\rightarrow w_0 = -181/216 = -0.838$

Λ CDM predicts $w = -1$ exactly; we predicted $w \neq -1$ before DESI measured it.

12 Hubble Tension Resolution Is Ad Hoc

Objection: “The distance formula modification $d = (c/H_0) \ln(1+z)$ is an arbitrary fix to match data.”

Response:

The logarithmic formula isn’t invented to fit the tension—it follows directly from the Q_c balance equation ($v_{\text{phase}} \times v_{\text{group}} = c^2$):

1. The constraint $v_g \times v_\phi = c^2$ is the standard waveguide dispersion relation (Feynman *Lectures* Vol. II Ch. 24; Jackson *Classical Electrodynamics* Ch. 8; Pozar *Microwave Engineering*). This is textbook physics, not a new hypothesis.
2. Wave packets slow cumulatively over cosmological distances (the vacuum acts as a lossy dispersive waveguide with coupling rate $\kappa_{\text{vac}} = H_0/c$)
3. Group velocity reduction integrates to $\ln(1+z)$ dependence
4. This yields $d = (c/H_0) \ln(1+z)$ instead of $d = cz/H_0$

The bias factor $B(z) = z/\ln(1+z)$ then explains why local measurements (SH0ES at $z \approx 0.044$) see $H_0 = 73.04$ while CMB sees $H_0 = 67.4$ —both are measuring the same underlying value of 71.48 km/s/Mpc with different systematic biases.

Prediction: SH0ES host galaxies at higher redshift should show systematically higher apparent H_0 values (since $B(z) > 1$ and increases with z). The observed correlation ($r = +0.40$, $p = 0.017$) supports this. A 10^5 -trial Monte Carlo simulation (Paper IV, Section 5.5) confirms the observed slope magnitude (2074 km/s/Mpc per unit z) is consistent with noise amplification (73.7th percentile of the distribution), not anomalous.

Where to find it: Paper IV, Sections 2–5

13 The 0.00% SH0ES Match Is Suspicious

Objection: “A perfect match to SH0ES is too good—this must be overfitting.”

Response:

The 0.00% match isn’t fitted—it’s a consequence of the derivation:

- $H_0 = 71.48$ km/s/Mpc comes from vacuum properties (no free parameters)
- Mean SH0ES redshift $\bar{z} = 0.044$ is an observational fact
- $B(0.044) = 1.022$ follows from the formula
- $71.48 \times 1.022 = 73.04$ matches SH0ES’s reported value

We didn’t tune anything to get this match. The derivation predicted it.

14 No Experimental Evidence

Objection: “There’s no direct experimental test.”

Response:

Four lines of experimental evidence:

1. **Walking Droplet Experiments:** Droplets self-organize into quantized orbits with double quantization (Bush, Couder, Fort).
2. **QED Precision Measurements:** Same mode structure appears in electron g-2 and fine structure constant.
3. **Casimir Effect Prediction:** Mode-counting predicts Casimir force modified by factor 2/3 (testable).
4. **SH0ES Host Galaxy Correlation:** Paper IV predicts higher- z hosts show higher apparent H_0 ; observed correlation $r = +0.40$, $p = 0.017$. Monte Carlo simulation (10^5 trials, Section 5.5) confirms slope magnitude is noise-dominated, while the sign and significance are the meaningful diagnostics.

15 Challenging Nobel Prize Work

Objection: “You’re challenging a Nobel Prize discovery (cosmic acceleration).”

Response:

We do not dispute the observations—the +0.171 mag trend in Type Ia supernovae is real. We offer an alternative interpretation: the wave packet distance formula accounts for the same trend without requiring dark energy.

Historical precedent shows Nobel-winning work is not immune from revision:

- 1926: Johannes Fibiger won for parasitic worm causing cancer (completely wrong—rats had vitamin A deficiency)
- 1938: Enrico Fermi won for “new elements” (actually observed fission products)
- 1949: António Egas Moniz won for lobotomy (now considered harmful)

The Nobel Foundation does not rescind prizes. Offering alternative interpretations is how physics advances.

Where to find it: Paper IV, Section 7 (On Nobel Prize Weight)

16 The 7/6 Factor Is Ad Hoc

Objection: “The 7/6 factor in your H_0 derivation appears arbitrary.”

Response:

The factor emerges from standard coupled oscillator physics:

- 3 phases from [111] projection $\rightarrow 120^\circ$ separation
- 2 quadratures (real + imaginary)
- 6 active modes $= 3 \times 2$

- 1 ground mode = center-of-mass mode ($\omega = 0$)
- Total: 7 modes, ratio $7/6 = (\text{total})/(\text{active})$

The center-of-mass mode is standard physics (Morin 2008, MIT 8.03). For N coupled oscillators, one normal mode has $\omega = 0$ and cannot exchange energy with other modes.

Where to find it: Paper IV, Section 2; Paper I, Section 5

17 Robustness Not Demonstrated

Objection: “Your $z = 0.5$ cutoff is arbitrary. Results may not hold for other choices.”

Response:

Tested sensitivity across z cutoffs from 0.3 to 0.7:

- This work shows smaller residual trends than Λ CDM (without Λ) across *all* cutoff choices
- Bootstrap resampling (1000 iterations) confirms 95% confidence intervals
- Leave-one-out analysis shows no single supernova dominates the result

Where to find it: Paper IV, Section 5 (Robustness Analysis)

18 Small Sample Size

Objection: “Your 30 supernovae sample is too small compared to Pantheon+ (1701).”

Response:

We use fewer supernovae deliberately. Large catalogs publish distance moduli processed through Λ CDM-dependent pipelines:

- K-corrections computed using Λ CDM cosmology
- Peculiar velocity corrections assume Λ CDM
- Standardization parameters fitted jointly with cosmological parameters

Testing Λ CDM alternatives with Λ CDM-processed data is circular. Quality over contaminated quantity.

Where to find it: Paper IV, Section 5 (On Sample Size)

19 Circular Reasoning in M_0 Calibration

Objection: “You calibrate M_0 with your formula then claim good fit. That’s circular.”

Response:

Both frameworks calibrate M_0 —unavoidable without geometric distance anchors. The difference is what else each requires:

- Λ CDM: Fits H_0 , Ω_Λ , Ω_m (3+ free parameters)
- This work: Derives $H_0 = 71.48$ km/s/Mpc from vacuum constants (0 free cosmological parameters)

Achieving equivalent fit with fewer parameters defines a more parsimonious model.

Where to find it: Paper IV, Section 7 (Parameter Comparison)

20 No QFT Derivation

Objection: “You don’t derive mode structure from quantum field theory.”

Response:

This work cannot be derived through QFT until QFT corrects its vacuum mode counting—the same assumptions that produce the 10^{120} vacuum energy catastrophe. Standard QFT integrates modes from $f = 0$ to Planck frequency without a ground state cutoff.

This work provides the corrected mode counting: three-phase structure with ground frequency cutoff at 160 GHz.

Where to find it: Paper II, Section 5 (Vacuum Discrepancy Resolution)

21 Λ CDM Has Dozens of Independent Probes

Objection: “ Λ CDM is constrained by dozens of independent probes. You’ve only addressed a few.”

Response:

Those probes appear independent but share common assumptions in data reduction:

- BAO: Sound horizon r_s calculated with Λ CDM $H(z)$
- CMB: H_0 fitted assuming Λ CDM expansion history
- Structure formation: Uses Λ CDM growth functions
- SNe Ia: M_0 calibrated with Λ CDM distances
- Weak lensing: Distance ratios assume Λ CDM $d(z)$

These are not independent constraints—they are the same assumption echoing through different datasets.

Where to find it: Paper IV, Section 7 (Where Assumptions Enter)

22 Where is the QFT Lagrangian?

Objection: “Where is the QFT Lagrangian? This needs proper quantum field theory foundation.”

Short Answer:

We derive from first principles (measured vacuum constants ε_0 , μ_0 , Z_0), but standard QFT formalism assumes continuous vacuum modes—the assumption that causes the 10^{122} cosmological constant problem. We’re not replacing QFT; we’re showing where its vacuum assumptions fail. Full QFT reformulation with discrete mode structure is important future work, but our predictions are testable now.

Detailed Response:

22.0.1 1. We DO Have First-Principles Derivation

The complete derivation chain:

Inputs (measured):

- $\varepsilon_0 = 8.854187812 \times 10^{-12}$ F/m
- $\mu_0 = 1.25663706212 \times 10^{-6}$ H/m

- $Z_0 = 376.730313668 \Omega$
- $c = 299,792,458 \text{ m/s}$

Derivation:

- Three-phase geometry $\rightarrow 120^\circ$ mode separation
- Fourier quantization $\rightarrow$ mode integers $\{5, 6, 17, 18, 22, 137\}$
- Mode structure $\rightarrow$ CMB peaks at $\ell = \{220, 540, 810, 1120, 1410, 1720\}$
- Mode partition $\rightarrow w_0 = -181/216 = -0.8380$
- Vacuum constraint $\rightarrow H_0 = 71.48 \text{ km/s/Mpc}$

Result: Zero free parameters. All predictions match observations within 1σ .

This IS first-principles physics. The derivation is complete.

22.0.2 2. Why No QFT Lagrangian?

Standard QFT vacuum treatment assumes continuous mode spectrum:

$$\mathcal{L}_{\text{vac}} = \int d^3k \rho(k)$$

This leads to vacuum energy density $\rho_{\text{vac}} \sim \int_0^{M_{\text{Planck}}} k^3 dk \sim M_{\text{Planck}}^4 \sim 10^{113} \text{ J/m}^3$.

Observed: $\rho_{\text{vac}} \sim 10^{-9} \text{ J/m}^3$.

Discrepancy: 10^{122} orders of magnitude—the “worst prediction in physics.”

Our finding: The problem is the continuous mode assumption $\int d^3k$.

Correct vacuum mode structure:

Modes: $\{5, 6, 17, 18, 22, 137, \dots\}$ [discrete geometric integers]

We cannot write a standard QFT Lagrangian because **standard QFT assumes the wrong thing**. The continuous mode assumption is what causes the 10^{122} error.

22.0.3 3. We’re Not Replacing QFT—We’re Correcting an Assumption

QFT remains valid for:

- Particle scattering (S-matrix accurate)
- QED precision (g-2, Lamb shift to 12 decimal places)
- Standard Model (electroweak, QCD predictions confirmed)

QFT fails for:

- × Vacuum energy (10^{122} error)
- × Dark energy w_0 (no prediction)
- × Fine structure constant origin (measured input, not derived)
- × CMB structure (no prediction)

Why the split? QFT’s particle interactions are correct. QFT’s vacuum mode counting is wrong (continuous vs. discrete).

We correct the vacuum assumption, not replace particle physics.

22.0.4 4. Historical Precedent: Physics First, Formalism Second

Maxwell's Electromagnetic Theory (1865):

- Derived EM from first principles
- Predicted EM waves, calculated c
- No quantum formulation
- QED came 80 years later (1948)
- **Maxwell was still right**

Bohr-Sommerfeld Atomic Theory (1913–1916):

- Derived spectra from quantization
- Predicted energy levels accurately
- No wave mechanics
- Schrödinger equation came 10–13 years later (1926)
- **Bohr-Sommerfeld was still right**

Effective Field Theory (1970s–present):

- Makes predictions without UV completion
- No full quantum gravity theory
- Widely used and validated
- **Still correct and predictive**

Our work (2024–present):

- Derives cosmology from vacuum geometry
- Predicts CMB, w_0 , H_0 from first principles
- No QFT reformulation yet
- Testable predictions: $D^{EE}/D^{TE} = 1/32$, Casimir = $2/3$
- **If confirmed → QFT reformulation urgent**

Pattern: Identify physics → Make predictions → Test → Develop formalism

22.0.5 5. Our Testable Predictions (Falsifiable)

If we're wrong, these will fail:

1. **CMB Polarization:** $D^{EE}/D^{TE} = 1/32 = 0.03125$. CMB-S4 will measure to $\sim 1\%$ by 2030.
2. **Casimir Force:** Geometric correction factor = $2/3$. Testable in laboratory now.
3. **CMB Peak Ratio:** $\ell_3/\ell_2 = 1.533$ (base geometric ratio $3/2$, corrected). Observed: 1.533 ± 0.015 (0.0σ). **Matches Planck data.**
4. **Hubble Correlation:** H_0 vs z : positive correlation. Observed: $r = +0.40$, $p = 0.017$ (2σ).

If confirmed $\rightarrow$ QFT needs reformulation with discrete modes

If refuted $\rightarrow$ Our framework is wrong

This is how science works.

22.0.6 6. Bottom Line

What we have:

First-principles derivation (measured ε_0 , μ_0 , Z_0)

Complete geometric mode structure

Zero-parameter predictions

Excellent agreement with observations ($\chi^2_{\text{red}} = 0.65$)

Four testable falsifiable predictions

Anti-numerology evidence (dual baryon asymmetry)

What we don't have:

$\triangle$ QFT Lagrangian formulation

Why? Standard QFT assumes continuous modes (wrong assumption). We show modes are discrete (correct physics). Can't force discrete physics into continuous formalism.

We're doing first-principles physics, just not in QFT language yet.

This is legitimate science.

Where to find it: Paper I, Section 8.2 (On QFT Derivation); Paper II, Section 5 (Vacuum Energy Resolution)

Summary

All major anticipated objections have been addressed in the companion papers. We welcome rigorous criticism and are committed to addressing substantive concerns.

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