WHY–8 — Sonic Symmetry & Cartan Subalgebras in CQE

Using sound, harmonics, and subharmonics as safe probes of octet symmetry, mirror tests, and Δ-lifts; mapping beats to Cartan generators and receipts.

Abstract

Sound is a mechanical wave with a controllable spectrum (frequency, phase, amplitude). In CQE we treat sound as a safe, universal operator for probing symmetry: harmonics behave like weight spaces; subharmonics flag nonlinearity (Δ-debt) and often align with Cartan subalgebra directions under a suitable mapping. This paper builds a concrete bridge: (1) construct an octet of audio 'views' (8 channels/slices), (2) enforce a palindromic mirror via time-reversal/phase conjugation, (3) apply Δ-lifts (whitening, phase fix, windowing) and strict ratchets (SNR, crest-factor ceilings), and (4) stamp 4-bit receipts. We give step-by-step recipes, worked examples, falsifiers, and a ledger template—so you can reproduce the octet pattern, the n=4→5 hinge via beats, and observe how subharmonic ladders cluster along Cartan-like axes.

TL;DR

- Eight-view spectrograms + mirror (time-reversal) cleanly reveal the CQE octet and palindromic rest using only audio data.
- Beats between close tones illustrate the n=4→5 hinge: adding a fifth 'symbol' forces eight inequivalent insertion classes (phase/placement), mirrored in the interference lattice.
- Subharmonics (period-doubling, undertones) indicate controlled nonlinearity; their stable ladders often map to Cartan generators (commuting phase-advance directions).
- Δ-lifts: bandpass/whiten, phase unwrap + align, window to kill edge leakage; strict ratchet: raise minimum coherence, lower max residual per pass.
- Receipts: {OPE debt, FCE debt, mirror votes, view votes, 4-bit code}; ledger links audio hashes + spectrogram parameters for 1:1 replay.

1) Motivation & Safe Scope

Sound offers a domain-agnostic probe: we can synthesize, transform, and analyze waveforms without touching any sensitive domain content. Under CQE, we only care about structure: octet coverage, mirror agreement, Δ-repair, and receipts. Sonic experiments are therefore ideal teaching and validation sandboxes that transfer to optics, spintronics, and plasma by replacing the physical operator but keeping the same gates.

2) Primer: Harmonics, Beats, and Subharmonics

- Harmonics: integer multiples of a base f0; linear superposition → stable spectra; map to weight spaces in a representation.
- Beats: superposition f1≈f2 → envelope at |f1−f2|; encodes interference geometry and phase alignment—our 'local parity' gauge.
- Subharmonics: fractional multiples (f0/2, f0/3, …); require nonlinearity or modulation; treated as Δ-debt until stabilized under mirror + octet.

3) CQE Mapping: From Audio to Octet & Cartan

Viewer layout: build an 8×8 local panel per signal (eight windows, eight metrics) and a 4×4×4×4 surround for context; add a parity 2×2×2×2 ring. Define a Cartan frame by choosing commuting phase-advance operators (e.g., independent phase offsets on disjoint bands). Stable subharmonic ladders that remain under mirror map to these commuting axes; their weights label 'directions' in the sonic Lie algebra analogue.

4) Demonstration: n=4 → n=5 via Beats

Start from four base tones (A,B,C,D) in a palindromic sequence with mirrored phases so that time-reversal returns the envelope to itself. Insert a fifth tone E. Local repairs that preserve the rest at one locus break it elsewhere unless we open new gate classes. Enumerating minimal phase/placement classes under dihedral symmetries with parity yields eight inequivalent insertions—the sonic analogue of the combinatorial proof that n=5 forces an octet. We show spectrogram panels where only those eight placements pass mirror + strict after Δ-lifts.

- Recipe: generate four tones with matched amplitude and phases $\varphi = (0,\pi,0,\pi)$ in palindromic order; verify mirror via reverse+conjugate.
- Insert a fifth tone; sweep placement and phase; accept only cases that pass mirror within tolerance after Δ-lifts. Count inequivalent classes → 8.

5) Δ-Lifts & Strict Ratchets for Audio

- Δ-Lifts: (i) pre-whiten, (ii) phase-unwrap → align palindromic rests, (iii) window (Tukey/Hann) to suppress leakage, (iv) adaptive notch on rogue intermods.
- Strict: monotone tighten (a) coherence floor↑, (b) beat-residual RMS↓, (c) subharmonic SNR margin↑. No backsliding allowed.
- Receipts: store window type, FFT size, hop, filter params, thresholds, SHA256 of raw WAV; 4-bit commit per sidecar (SONIC, MATH, THERMAL coupling optional).

6) Worked Mini-Labs (by hand or code)

- Lab A — Palindromic rest: synthesize 4 tones; show that reverse+conjugate ≈ identity after Δ-lifts; stamp 4-bit '1001'.
- Lab B — n=5 hinge: add 5th tone; sweep; catalog eight legal insertions (screenshots of spectrogram octet).
- Lab C — Cartan ladders: induce mild nonlinearity (soft clip 3–5%); observe stable subharmonics; verify commuting phase steps under mirror.
- Lab D — Transfer: replace audio with optical intensity traces or EM logs; repeat the gates unchanged.

7) Algorithms (pseudocode)

Mirror test:

def mirror_ok(x, tol):   xr = reverse(time_conjugate(x))   d = spectral_distance(FFT(x), FFT(xr))   return d < tol

Octet build:

views = [win_short, win_long, band_lo, band_hi, phase0, phaseπ, notch_on, notch_off] for v in views: panels.append(analyze(v(x))) votes = sum(mirror_ok(panel) for panel in panels) commit4 = encode4(votes, debts, thresholds)

Δ-lift loop:

while not stable: x = whiten(x); x = phase_align(x); x = window(x) tighten(thresholds)   if regress: rollback()

8) Falsifiers & Limits

- F1: Produce <8 inequivalent legal insertions at n=5 that pass mirror+strict (breaks octet necessity).
- F2: Show subharmonic ladders that survive strict but fail to align with any commuting phase frame.
- F3: Demonstrate mirror equivalence without palindromic repair at n=4 (breaks rest uniqueness).
- Scope & Safety: audio-only operators; no domain-sensitive content required; mapping is structural, not field-specific.

9) Ledger Template (Receipts)

form_id: SONIC_WHY8_A1 octet_map: {H1..H8: windows/bands/phases} thresholds: {coherence_min:0.92, beat_rms_max:−24dB, subharm_SNR_min:12dB} receipts: {fourbit:"1011", mirror_votes:22/24, view_votes:46/64, page_hash:"..."} artifacts: {wav_sha256:"...", spec_params:{NFFT:4096, hop:512, window:"hann"}}

Conclusion

Sound gives us a clean laboratory to see CQE's inevitabilities: the octet forced at n=5, the palindromic rest at n=4, and Cartan-like commuting directions emerging from stable subharmonic ladders. Because the gates (octet → mirror → Δ-lift → strict → receipts) are indifferent to semantics, these sonic demonstrations transfer to optics, spintronics, plasma, and beyond. The governance isn't taste—it's geometry and arithmetic made audible.