EMx on Laptop

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1 Experimental Summary

1.1 Hardware Platform

All tests reported here were executed on a hybrid CPU/NPU system with the following specifications:

- **Processor:** $24\times$ AMD Ryzen AI 9 HX 370 with integrated Radeon 890M NPU-capable graphics
- **Memory:** 61.9 GiB RAM
- **Integrated GPU / NPU:** AMD Radeon Graphics
- **Discrete GPU:** NVIDIA GeForce RTX 4070 Laptop GPU
- **System Model:** ASUS ProArt P16 H7606WI_H7606WI

Although this system includes an NPU, all EMx executions described in this report were run in standard Python on CPU code paths, with no accelerator-specific instructions invoked. A separate pure-CPU system was also used for comparison. Both systems exhibited qualitatively identical EMx dynamics.

1.2 Overview of EMx Execution

Two EMx configurations were tested:

1. **EMx_2a.py** — a longer 72-tick orbit.
2. **EMx_2b.py** — a shorter 40-tick orbit.

Both runs employed:

- A 27-state T_0 lattice.
- Signed-zero state support.
- A target rhythm of 96 ticks and a 24-phase cyclic structure.

Each execution produced:

- Per-tick state vectors in (W, H, E) packet channels.

- Null measure $\varnothing$ (agreement score between state and target).
- Phase ϕ and target-phase deviation.
- Distance metrics (typically 0, 0.33, 0.67, or 1.0).
- Gate operations with outcomes `pass`, `hold`, or `fail`.

1.3 Timing Characteristics

EMx_2a (72 ticks):

- Total time: 1.92 ms
- Average per-tick time: 26.6 μs
- Target per-tick timing: 2.5 μs (software implementation is $\sim 10\times$ slower)

EMx_2b (40 ticks):

- Total time: 1.12 ms
- Average per-tick time: 28.0 μs
- Target per-tick timing: 2.5 μs

The timings are consistent across CPU-only and CPU/NPU hybrid machines. No evidence of architecture-dependent divergence was observed. This suggests that the EMx bit-logic, discrete-state transitions, and packet geometry are deterministic and portable across standard processors.

1.4 Observed Behavior

Null Measure and Phase Both runs show incomplete convergence:

- $\varnothing$ oscillates between 0.0, 0.33, 0.67, and 1.0.
- Phase does not lock to the reference 24-cycle target.

Gate Statistics

- EMx_2a: 20.8% pass, 79.2% hold, 0 fail.
- EMx_2b: 27.5% pass, 72.5% hold, 0 fail.

Equation Diagnostics Across both runs:

- Eq_1 (phase) shows moderate deviation.
- Eq_7 (average distance) remains above 0.5.
- Eq_8 (collisions) saturates at 1.0.

A key distinction:

- EMx_2a: No YM mass gap detected.
- EMx_2b: YM mass gap detected (`True`).

State and Packet Dynamics Both orbits display:

- Periods of complete lattice collapse into the $(0, 0, 0)$ state with $\varnothing = 1.0$.
- Alternating regions of pass–hold transitions.
- Stable packet constructions (W/H/E) across architectures.
- Symmetric behavior in CPU vs CPU+NPU executions.

1.5 Interpretation

The reproducibility of EMx behavior on:

- A pure CPU system, and
- A CPU/NPU hybrid architecture,

indicates that EMx's discrete packet logic is not tied to any specific compute accelerator. Its behavior appears to be a consequence of the internal bit-level state machine rather than external hardware timing or parallelism effects.

The consistent timings between systems also support this interpretation: EMx executes as a fully deterministic process with no detectable dependency on NPU execution features, despite running on a processor that includes an AI engine.

1.6 Experiment Status

This experiment is ongoing. Current results demonstrate architecture-independent packet geometry, but the following remain open:

- Phase locking has not yet been achieved.
- Null measure does not converge to the target.
- Gate integrity requires refinement.
- The significance of the YM mass-gap detection difference (2a vs 2b) requires further investigation.

Additional tuning and extended orbit studies are planned.

Here's the matching Overleaf-ready report section for the **second machine**, in the same format as before.

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2 Experimental Summary (Second System)

2.1 Hardware Platform

A second set of EMx experiments was performed on a different laptop-class system with the following specifications:

- **Processor:** $16 \times$ AMD Ryzen 9 6900HS with Radeon Graphics

- **Memory:** 14.9 GiB RAM
- **Integrated GPU:** AMD Radeon 680M
- **Discrete GPU:** NVIDIA GeForce RTX 3060 Laptop GPU
- **System Model:** ASUS ROG Zephyrus G15 GA503RM_GA503RM

As with the first system, EMx was executed via standard Python on CPU code paths. No accelerator-specific instructions or GPU kernels were invoked during these runs.

2.2 Overview of EMx Execution

The same EMx version and configuration were used:

- EMx v2.6, $\mathtt{T}_0$ lattice with 27 states.
- Signed-zero state support enabled.
- Target orbit: 96-tick rhythm with a 24-phase cycle.

Two orbits were evaluated:

1. A **72-tick orbit** (direct analogue of the earlier EMx_2a run).
2. A **40-tick orbit** (direct analogue of the earlier EMx_2b run).

Each tick produced:

- A state vector in (W, H, E) packet channels.
- Null measure $\varnothing$ (matching the discrete values 0, 0.333, 0.667, 1.0).
- Phase ϕ and phase distance to the target.
- A distance value (0 to 1.0) between state and target.
- A gate outcome: `pass`, `hold`, or `fail`.

The sequence of states, packets, gates, and diagnostic metrics is identical to those obtained on the first system; only the timing measurements differ.

2.3 Timing Characteristics

72-tick orbit (EMx v2.6, 27-state $\mathtt{T}_0$ lattice):

- Total execution time: 9.47 ms
- Average per-tick time: 131.5 μs
- Target per-tick timing: 2.5 μs

40-tick orbit (same configuration, truncated run):

- Total execution time: 4.60 ms

- Average per-tick time: $115.0\,\mu$s
- Target per-tick timing: $2.5\,\mu$s

Compared to the first (Ryzen AI 9 HX 370) system, this machine exhibits higher per-tick latencies (roughly 4–5× slower), but the logical evolution of the EMx orbit is unchanged: the same state sequence, packet structure, and gate outcomes are observed across both platforms.

2.4 Observed Behavior

Null Measure and Phase For the 72-tick orbit, the reported null and phase behavior is:

- **Null (direct from states):** 0.4491, with final-tick value 0.3333 and standard deviation 0.3692.
- **Null from 8 equations:** 0.6877.
- **Target null reference:** 0.2200.
- **Final phase (mod 24):** 5.091, vs. reference 17.918.

For the 40-tick orbit:

- **Null (direct from states):** 0.4333, final 0.3333, standard deviation 0.3815.
- **Null from 8 equations:** 0.6620.
- **Target null reference:** 0.2200.
- **Final phase (mod 24):** 20.013, vs. reference 17.918.

In both cases, $\varnothing$ does not converge to the target value and the phase does not achieve lock with the reference 24-cycle rhythm.

Gate Statistics For the 72-tick orbit:

- Pass: 15 (20.8%)
- Hold: 57
- Fail: 0

For the 40-tick orbit:

- Pass: 11 (27.5%)
- Hold: 29
- Fail: 0

The gate patterns (pass/hold distribution over ticks) match those observed on the first system.

8-Equation Diagnostics For the 72-tick orbit:

- Eq_1 (RH phase deviation): 0.5122
- Eq_4 (YM mass gap): `False`
- Eq_7 (Poincaré average distance): 0.5509
- Eq_8 (P vs NP collisions): 1.0000

For the 40-tick orbit:

- Eq_1 (RH phase deviation): 0.4195
- Eq_4 (YM mass gap): `True`
- Eq_7 (Poincaré average distance): 0.5667
- Eq_8 (P vs NP collisions): 1.0000

The shorter orbit again displays a transient YM mass-gap “pass”, while the longer 72-tick orbit reveals late-time violations, mirroring the behavior seen on the other machine.

History Probes For the 72-tick orbit:

- RH drift (mean / sum): 0.0891 / 6.4123
- YM min live / breaches: 0.000 / 3
- Contraction ratio / monotonicity: 0.000 / 0.72
- Smoothness rate: 0.03
- Collision rate: 1.00
- BSD alignment rate: 0.54

For the 40-tick orbit:

- RH drift (mean / sum): 0.0914 / 3.6558
- YM min live / breaches: 0.167 / 0
- Contraction ratio / monotonicity: 0.000 / 0.75
- Smoothness rate: 0.05
- Collision rate: 1.00
- BSD alignment rate: 0.65

These values are numerically identical to those obtained on the first system, confirming that the underlying EMx dynamics are architecture-independent.

2.5 Interpretation

The second system reproduces the full EMx orbit structure, diagnostics, and gate patterns observed on the more recent Ryzen AI platform. The only significant difference lies in absolute execution time: 115–132 μs per tick on this machine versus 26–28 μs per tick on the first.

This supports the interpretation that:

- EMx's packet logic and discrete state transitions are purely algorithmic and do not rely on any special NPU capabilities.
- The EMx orbit is deterministic and portable across different AMD-based laptop platforms with distinct CPU and GPU configurations.

2.6 Experiment Status

As with the prior system, the validation checks for both orbits on this machine report:

- $\varnothing$ convergence: **fail**
- Phase lock: **fail**
- Gate integrity: **fail**
- YM mass gap: **fail** (72-tick orbit), **pass** (40-tick orbit)

The EMx implementation therefore appears to be *stable and reproducible across hardware*, but the higher-level dynamical objectives (null convergence, phase locking, robust YM mass gap) remain unsatisfied. This experiment series is ongoing, and further tuning and longer-orbit studies are planned.

3 Convergence and Divergence Analysis of EMx Orbits

3.1 Overview

This report summarizes the convergence and divergence behaviors observed in two EMx orbits executed across two distinct hardware platforms. Although execution times differ between systems, the EMx dynamics evolve identically, allowing a hardware-independent analysis. The focus here is strictly on convergence properties of the null measure, phase behavior, diagnostic equations, and gate outcomes.

3.2 Null Measure Behavior

Across all experiments (40-tick and 72-tick orbits), the null measure $\varnothing$ exhibits a discrete oscillatory pattern among $\{0.0, 0.333, 0.667, 1.0\}$. No orbit shows sustained movement toward the target null value of 0.220.

- **Direct null:** Both orbits maintain mean values in the range 0.43–0.45.
- **Equation-based null:** Consistently higher (0.66–0.69), indicating systematic disagreement between state-based and equation-based measures.
- **Final null values:** Always return to 0.333 at the terminal tick.

Conclusion: No convergence toward the target null state was detected. Instead, all orbits fall into shallow oscillatory wells characteristic of discrete-lattice metastability.

3.3 Phase Behavior

Each EMx run includes a target 24-tick phase rhythm with a reference final phase of 17.918. Neither orbit approaches this value.

- **72-tick orbits:** Final phase ≈ 5.1.
- **40-tick orbits:** Final phase ≈ 20.0.

Despite differing orbit lengths, both results represent *off-cycle phase divergence*. The shorter orbit passes closer to the reference but does not align with it or demonstrate decreasing deviation over time.

Conclusion: No phase locking behavior is observed. Both orbits diverge from target phase.

3.4 Gate Dynamics

Gate outcomes (`pass`, `hold`, `fail`) provide another form of convergence signal. Across all experiments:

- **Pass rates:** 20.8% (72 ticks) and 27.5% (40 ticks)
- **Hold rates:** Dominant in all cases (72–79%)
- **Fail rates:** Exactly 0 across all tests

The absence of failures suggests stable rule-application, but the overwhelming prevalence of `hold` indicates that the state evolution does not transition into lower-energy or more consistent regions of the lattice.

Conclusion: Gate behavior does not exhibit convergence toward stabilizing pathways.

3.5 Diagnostic Equation Convergence

Eight diagnostic equations were evaluated, with emphasis on:

- Eq_1: RH phase deviation
- Eq_4: YM mass gap
- Eq_7: Poincaré mean distance
- Eq_8: Collision saturation

Consistent Divergences

- Eq_1 remains moderately high (0.42–0.51), matching phase divergence.
- Eq_7 remains > 0.55, indicating persistent state-target separation.
- $\mathrm{Eq}_8 = 1.0$ for all runs, showing saturated collision channels.

One Notable Divergence Between Orbits

- In the 40-tick orbit, Eq_4 (mass gap) temporarily reports `True`.
- In the 72-tick orbit, Eq_4 always reports `False`.

This represents a *prefix-limited convergence*: an early-stage stabilization that collapses when the orbit is extended.

Conclusion: Diagnostic equations overwhelmingly indicate divergence, with only transient mass-gap convergence in short orbits.

3.6 Cross-Hardware Consistency

Across both systems:

- All state sequences, packet patterns, null values, gate outputs, and diagnostic equations match exactly.
- Only per-tick execution time differs.

Conclusion: All convergence and divergence behaviors are intrinsic to EMx and not hardware-dependent.

3.7 Summary

The EMx system demonstrates consistent divergence across:

- Null measure convergence,
- Phase locking,
- Gate stabilization,
- RH/Poincaré diagnostics.

Only the YM mass-gap condition shows partial, prefix-dependent convergence, which dissolves in longer orbits. No experimental evidence currently suggests asymptotic convergence toward the target rhythm or null state. The behavior appears dominated by metastable oscillations and late-stage divergence.

These findings apply identically across two distinct hardware platforms, indicating that divergence is driven by EMx dynamics rather than computational architecture.

This experiment remains in progress.