BCQM VII Stage–2 Checkpoint
A3 Scale-Up: N=16 and N=32 stress tests (v0.1)

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Purpose

This checkpoint consolidates the A3 scale-up runs at $N = 16$ and $N = 32$ (hits1 cloth, x10 epoch, bins=20, $n = 0.8$, 5 seeds). The goal is to test whether the Stage–2 pivot conclusions—stable mesoscopic "cloth" communities, stable super-graph structure, and thread locality on the super-graph—persist beyond the small-N regime.

Run definitions

Common settings. Both scale-up runs use the same regime:

- Cloth baseline: hits1 (`min_bin_hits`=1), $W_{\text{coh}} = 100$, bins=20, x10 epoch.
- Cross-link pressure: $n = 0.8$.
- Seeds: 56791–56795.
- Logging: `store_lists=true` to record `core_edges_used` and `core_events_used`; and `trace_threads=true` with `trace_stride=1` to produce `cloth_trace` (per-bin per-thread end-of-bin event IDs and core-mask).

Outputs.

- Run folders: `outputs_cloth/gateA3_N16_hits1_x10_bins20_n0p8/` and `outputs_cloth/gateA3_N32_hits1_x10_bins20_n0p8/`.
- Summary CSVs (generated locally): `csv/gateA3_N16/*` and `csv/gateA3_N32/*`, including run summaries and ball-growth pairwise stability tables.

N=16 results (high-level)

Run health

The $N = 16$ runs are well-behaved: the cloth core is large and connected, trace logging is enabled for all seeds, and the Stage–1 connectivity indicators remain in-family ("space on").

Cloth geometry stability

Across the 5 seeds, cloth ball-growth fraction curves $|B(r)|/|C|$ are extremely stable (pairwise L2 distances of order 10^{-4}), indicating that the geometry class remains tightly reproducible at $N = 16$.

Interpretation

At $N = 16$, the high-n regime remains close to "all core": halo counts are small compared to the core. This is consistent with a dominant coherent population and provides a clean baseline for community and super-graph tests.

N=32 results (high-level)

Run health

The $N = 32$ runs are also stable and in-family ("space on"; trace logging present; no pathological warnings). The core cloth is connected and diagnostic-stable, but the core/halo decomposition becomes nontrivial.

Core/halo structure

Unlike $N = 16$, at $N = 32$ the halo contribution is substantial (large persistent event and edge counts outside the dominant core). This is a desirable property for Stage–2: it places the model in a more realistic regime where a stable core background coexists with a significant ambient population.

Cloth geometry stability

Even with a large halo, the cloth geometry diagnostic remains stable: pairwise L2 distances between normalised ball-growth curves remain small (order 10^{-3}). This supports the "stability at the level of geometry class, not microstructure" interpretation at larger N.

Gate–4 localisation at N=32 (physics proxy)

All-used partition and super-graph (recommended)

Using `partition_source=all` and `supergraph_source=all` yields full mapping coverage (coverage = 1, missing labels = 0, no infinite distances). In this regime, hop-distance motion on the super-graph remains strongly local:

- all inter-bin transitions lie in $d \in \{0, 1, 2\}$ with $P(d \geq 3) = 0$,
- probability mass concentrates at $d = 0$ and $d = 1$ (dominant local motion),
- core versus halo hop distributions are similar, with halo at most slightly "rougher" (small increase in $d = 2$ mass).

Thus, even at $N = 32$ with a nontrivial halo, threads respect the emergent coarse geometry.

Core-only partition/super-graph (diagnostic caveat)

Using `partition_source=core` and `supergraph_source=core` yields very low mapping coverage (about 8%), with hundreds of unmapped transitions per seed. Hop statistics in this mode are therefore computed on a small and biased subset of transitions and should not be used for physical claims. This is a methodological result: localisation tests require a partition/super-graph that covers the traced event IDs, which at larger N and nontrivial halo implies an all-used construction.

Interpretation and stake-in-the-ground

These A3 scale-ups support the Stage–2 pivot claims beyond the small-N regime:

- The hits1 cloth baseline remains connected and geometry-diagnostic stable at $N = 16$ and $N = 32$.
- At $N = 32$, a large halo emerges naturally while cloth-level diagnostics remain stable, reinforcing the "core+ambience" interpretation.
- Gate–4 localisation (threads move locally on the super-graph) holds in the high-n regime at $N = 32$ when the partition and super-graph are built from all-used edges/flows.

In short: scale-up does not break the pivot; instead it strengthens it by moving from near-all-core behaviour (N=16) to a regime with a meaningful ambient population (N=32) while preserving stable coarse geometry and local motion on the emergent substrate.

Next steps

1. Optional algorithm-family cross-check (Leiden) for Gate 1–3 if required.
2. Partition-source sensitivity formalisation: compare Gate 1–3 outputs for `partition_source=core` vs `all` in the low-n regime.
3. Extend localisation tests to $n = 0.4$ at higher N if desired, using all-used partitions for full coverage and meaningful core/halo comparisons.