A Path to Knots Formation in an Adaptive Medium, where Cohort Formation with Kickback Cascades Lead the Way

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Abstract—This note proposes a path toward knot-like organized structure in an Adaptive Medium (AM): a recursively adapting field whose local state responds to both external drive and its own neighbourhood. Within that Medium, microscopic vibrational degrees of freedom can phase-lock on steep density slopes into compact, particle-like cohorts. Cohort emission leaves a local vacancy; that vacancy is filled by vacancy backfill from the cell behind the shot (opposite the emission direction). Backfill steepens the upstream face, so emission regenerates and the active lip retreats into remaining dense fuel—a kickback cascade—until a weaker valley brakes the process. Cohorts, wakes, and cascades are presented as the dynamical bridge from a continuous Adaptive Medium toward string- and knot-like organization. The account is conceptual and illustrated by interactive GPU simulations; it is not offered as a closed continuum theorem.

Index Terms—Adaptive Medium, cohort formation, vacancy backfill, kickback cascade, knots, interactive simulation

I. Introduction

Organized structure in continuous media often begins not with particles inserted by hand, but with local locking of finer degrees of freedom: avalanche slabs, breaker fronts, and the successive jumps of a shallow waterfall. The same intuition motivates the present program. We start from an Adaptive Medium—a field that senses its neighbourhood and adapts recursively—and ask how that Medium can support coherent moving packets (cohorts), how those packets can force an upstream retreat of their ignition lip (kickback cascades via vacancy backfill), and how such dynamics open a path toward string- and knot-like organization in higher dimensions.

Section II introduces the Adaptive Medium as the foundation. Section III describes cohort formation as locked vibrations on steep slopes. Section IV defines vacancy backfill and kickback cascades. Section V presents free-running simulation examples. Section VI sketches the path toward knots. Section VII discusses scope and limits.

II. Adaptive Medium

A. What the Medium Is

An Adaptive Medium is not ordinary color diffusion and not a passive backdrop for particles. It is a spatially extended state that (i) receives temporary external drive (sources), (ii) senses nearby source and nearby Medium deformation, and (iii) updates recursively, so already-adapted neighbourhoods participate in further adaptation.

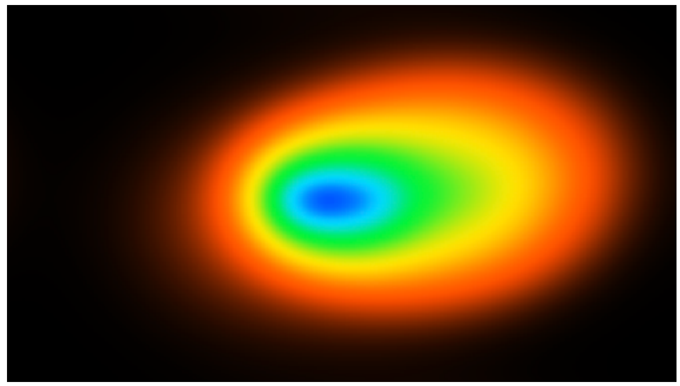

Fig. 1. Adaptive Medium response under localized drive (illustration from the signed thermal AM hot-baseline simulation). The Medium is a continuous adapting field: nested deformation around a driven core, not a sprayed particle layer. Source: Shadertoy ffK3Wh [1].

In the one-sided thermal baseline used here, zero degrees is the hot, resting, high-content baseline; negative temperatures (equivalently, increasing cold deformation) represent progressive density loss or deformation away from that baseline (Fig. 1).

B. Signed Thermal Picture

A convenient implementation stores a signed adaptive state together with a temporary source and a source-presence channel. Hot and cold need not be two disconnected reservoirs: overlapping input can warm, cool, cancel, and replace smoothly. Each cell combines an external push from nearby source temperature with a recursive contribution from nearby Medium deformation. The result is a Medium that remembers recent structure while slowly restoring toward baseline, and that can host sharp spatial slopes between high-content and low-content regions.

C. Why the Medium Comes First

Cohorts are not fundamental particles dropped onto an empty grid. They are organized subsets of the Medium's vibrational content. Without Adaptive Medium structure—neighbourhood sensing, recursive adaptation, baseline and deformation—there is no meaningful density slope to lock, no vacancy to backfill, and no cascade to walk. "Density Medium" in earlier informal notes should be read as this Adaptive Medium content field, not as a separate theory.

III. Cohort Formation

A. Vibrations and Locking

Let $\rho(\mathbf{x}, t)$ denote local Medium content (high ρ: abundant vibration; low ρ: sparse Medium). On shallow gradients, vibrations remain disordered. On a sufficiently steep slope,

$$g = |\nabla \rho| > g_{\min}, \quad \rho > \rho_{\min}, \tag{1}$$

a local bunch of vibrations phase-locks into a compact packet: a cohort, with mass m and shared direction

$$\hat{\mathbf{v}} = -\frac{\nabla \rho}{|\nabla \rho|} \tag{2}$$

(downhill, toward lower content). Formed mass scales roughly as

$$m \propto \rho \frac{g}{g_{\min}}. \tag{3}$$

The everyday image is a shallow waterfall: tiny modes pack into successive jumps that move more solidly than the unlocked background (Fig. 2).

B. Particle-like Transport

Once locked, a cohort behaves as a coarse particle or compact distribution: it carries momentum, can excavate a wake as it travels, and may later disperse when Medium content or coherence falls (dispersal increasing with sparsity $1 - \rho$). Fuller implementations add entrainment, steering, and internal moments; those enrich transport but are secondary to locking and emission.

IV. Vacancy Backfill and Kickback Cascades

A. Vacancy After Emission

Emission removes organized content from the release cell. That removal is a vacancy: a local drop in density pressure / Medium content at $\mathbf{x}$. Without a directed response, the lip would nick once and freeze, or refill isotropically and lose the cascade.

B. Vacancy Backfill

Vacancy backfill fills that hole from behind—from the neighbour opposite the shoot direction:

$$\begin{aligned} \Delta\rho(\mathbf{x}) &\propto -m, \\ \Delta\rho(\mathbf{x} - \hat{\mathbf{v}}) &\propto -m. \end{aligned} \tag{4}$$

Direction matters: back names the upstream cell ($\mathbf{x} - \hat{\mathbf{v}}$); fill names compensation of the vacancy left by the departing cohort. The modelling contract is: no cohort is released without vacancy backfill. On a curved lip, $\hat{\mathbf{v}}$ is the local outflow axis; backfill points opposite that axis (toward the focus of a concave front).

C. Kickback Cascade and Brake

Backfill steepens the upstream face. If g still exceeds $g_{\min}$, emission repeats slightly behind the previous site. The active lip therefore retreats into the remaining high-content plateau: a kickback cascade. The cascade ends when the lip enters a brake region of weaker contrast ($g < g_{\min}$), even if dense fuel remains elsewhere.

V. Illustrative Simulations

The following interactive GPU exhibits are free-running implementations of pieces of this program. They are examples for reading the mechanism, not a claim that every conservation detail is closed in multipass buffer packing.

A. Adaptive Medium Baseline

Figure 1 and Shadertoy ffK3Wh [1] (Signed Thermal AM Hot Baseline) isolate the Medium: recursive adaptation under temporary thermal drive, hot baseline at zero degrees, cold as deformation / content loss.

B. Kickback Cascade Exhibit

Figure 3 and Shadertoy sfK3R3 [2] (Cohort Avalanche Kickback Test) arrange asymmetric valleys around a high-content plateau. A deep valley on one side creates a steep lip; cohorts emit downhill; vacancy backfill retreats the lip into the plateau until a shallower valley brakes the cascade.

C. Trailblazers Networks

Figures 4 and 5 show broader cohort networks in Adaptive Medium—travel, wakes, and organized streams—from Shadertoy 7fyGzG [3] (Trailblazers Network in AM) and ffK3RG [4] (Trailblazers Network in AM 2).

D. Three-Dimensional Outlook

Figure 6 shows a three-dimensional free-running implementation (Shadertoy 7cyGzt [5]). It is included as an example in the same spirit as the two-dimensional networks: evidence that the Medium-plus-organization program extends beyond a single planar cascade test.

VI. A Path Toward Knots

Knots are not postulated as primitive objects. The path suggested here is compositional:

1) Adaptive Medium provides a continuous, recursively adapting content field with baseline and deformation.
2) Cohort formation locks vibrations into particle-like packets on steep slopes.
3) Vacancy backfill ties every emission to an upstream content draw, so lips can move and regenerate slope.
4) Kickback cascades produce extended structured fronts and wakes rather than isolated one-shot sparks.

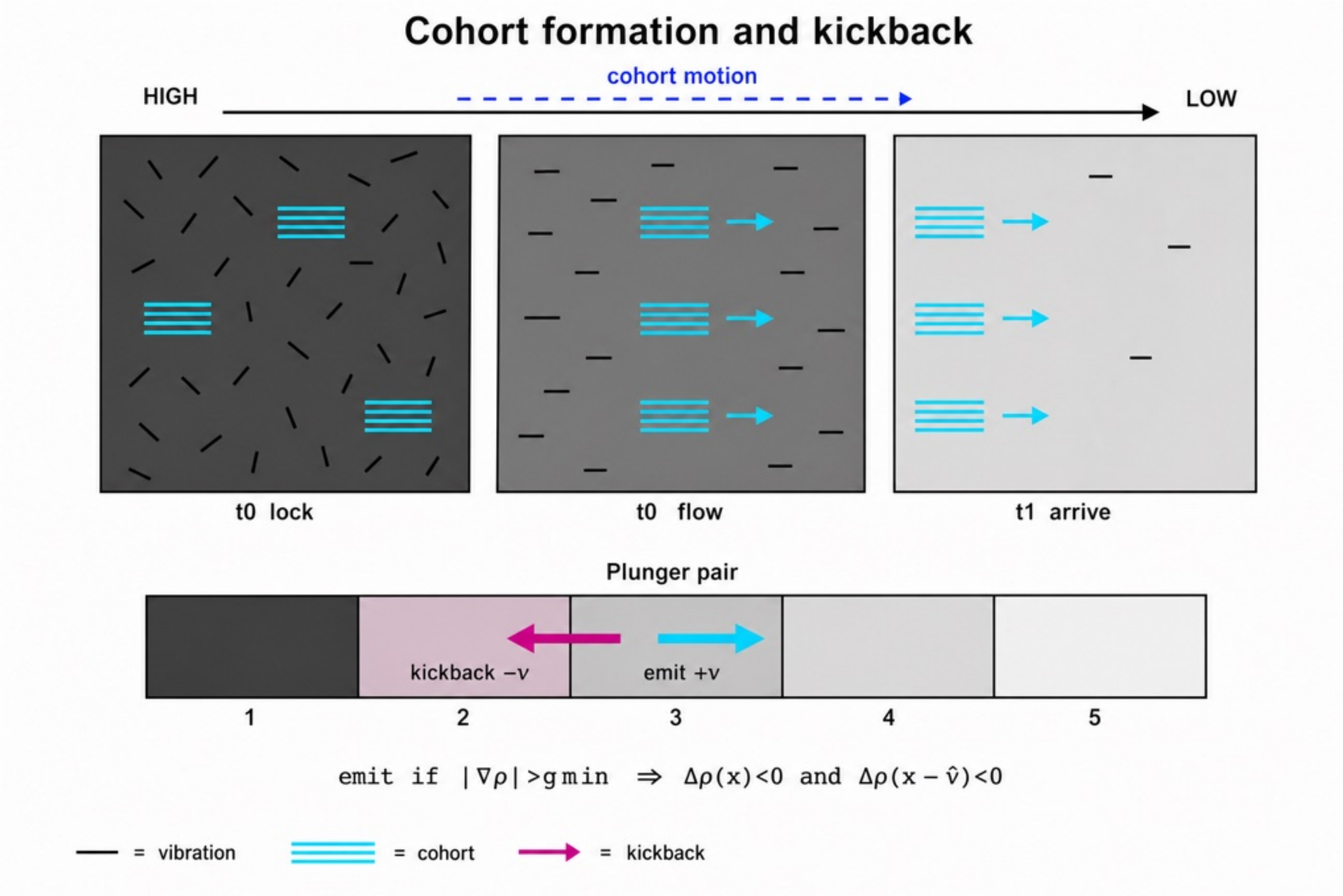

Fig. 2. Cohort formation and vacancy backfill (concept). Top: vibrations lock into cohorts and move from high to low content (t_0 lock / flow, t_1 arrive). Middle: emission $+\mathbf{v}$ leaves a vacancy that is backfilled from the cell behind ($-\mathbf{v}$). Bottom: emission condition and mandatory content losses at the emit site and upstream neighbour.

5) Networks and 3D allow streams to meet, braid, and—in the longer program—close into string and knot topologies.

In that sense, cohort formation with kickback cascades lead the way: they are the dynamical steps by which an Adaptive Medium can grow organized, persistent structure rather than only diffuse deformation.

VII. Discussion

A. What Is Claimed

We claim a readable mechanism and a research path: Adaptive Medium as foundation; cohorts as locked Medium content; vacancy backfill as the directed compensation of emission; kickback cascades as upstream lip retreat; knots as a longer-term organizational target.

B. What Is Not Claimed

We do not claim a finished continuum PDE of knots, nor that every interactive multipass implementation already enforces perfect conservation under buffer-channel limits. GPU exhibits illustrate geometry and timing; dedicated solvers remain the natural next vehicle for quantitative conservation studies.

C. Naming

Vacancy backfill replaces informal "plunger" language: it states that emission leaves a vacancy and that the vacancy is filled from behind. Kickback cascade names the regenerated upstream walk of the lip.

VIII. Conclusion

Starting from an Adaptive Medium, steep slopes can lock vibrational content into cohorts; emission leaves a vacancy that is backfilled from upstream; the resulting kickback cascade retreats the lip until a brake valley stops it. Trailblazer networks and three-dimensional exhibits show the same program running more freely. Together these steps outline a path toward knot formation: Medium first, then cohorts, then vacancy backfill and cascades, then structured meeting of streams in higher dimensions.

References

[1] M. Van de gaer, "Signed Thermal AM Hot Baseline," Shadertoy ffK3Wh. [Online]. Available: https://www.shadertoy.com/view/ffK3Wh

[2] M. Van de gaer, "Cohort Avalanche Kickback Test," Shadertoy sfK3R3. [Online]. Available: https://www.shadertoy.com/view/sfK3R3

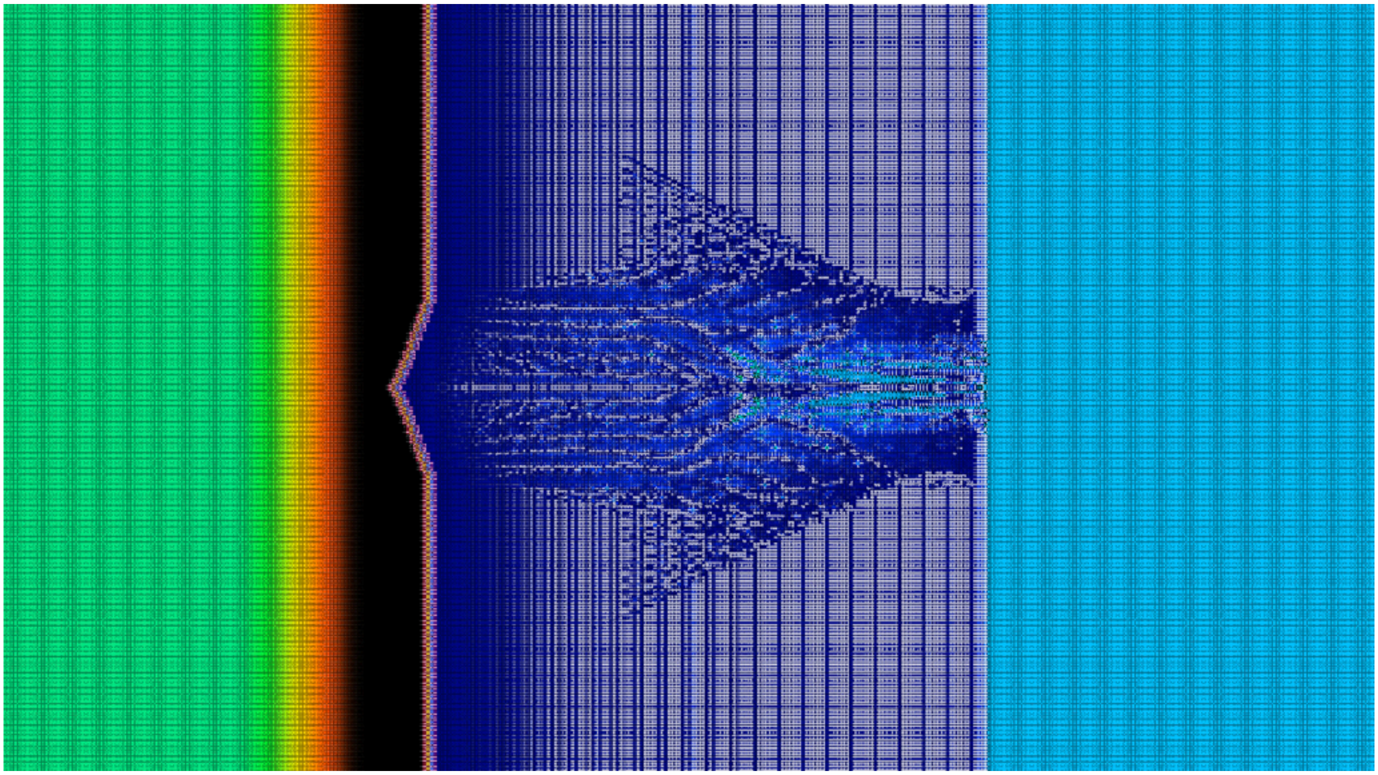

Fig. 3. Cohort avalanche / kickback cascade on an Adaptive Medium plateau. High-content plateau (black) meets a deep low-content valley; cohorts emit downhill while vacancy backfill retreats the lip upstream until a shallower brake valley weakens the slope. Source: Shadertoy sfK3R3 [2].

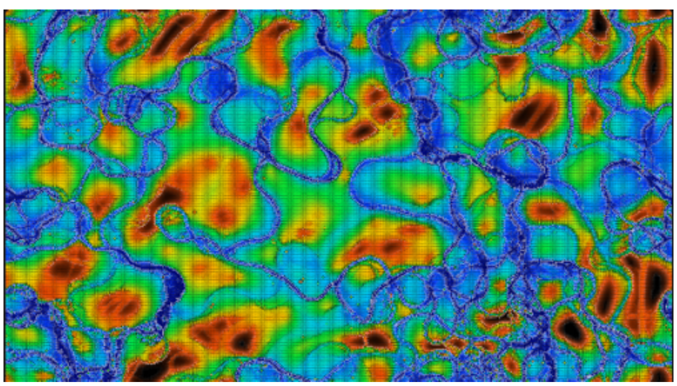

Fig. 5. Trailblazers network in Adaptive Medium, second exhibit (example). Source: Shadertoy ffK3RG [4].

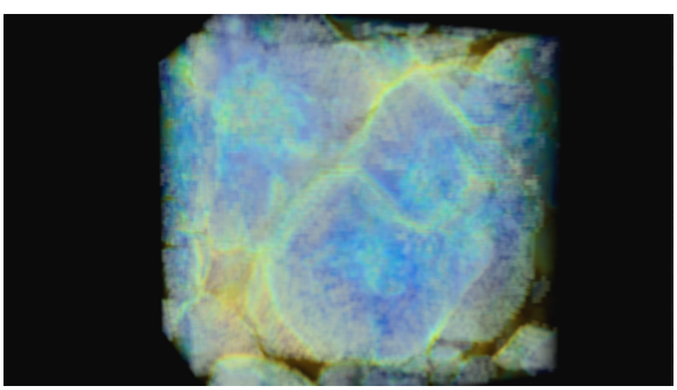

Fig. 6. Three-dimensional Adaptive Medium / organization exhibit (example). Source: Shadertoy 7cyGzt [5].

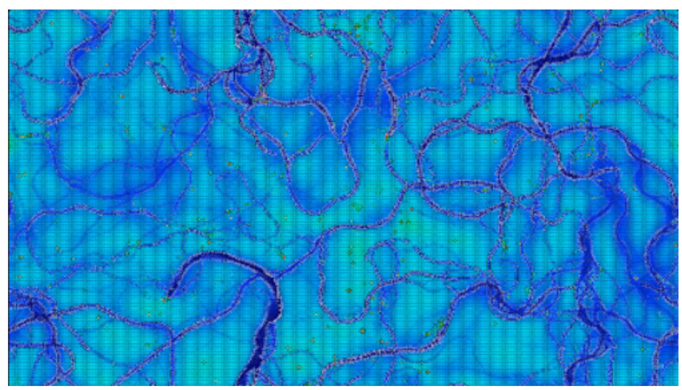

Fig. 4. Trailblazers network in Adaptive Medium (example). Source: Shadertoy 7fyGzG [3].

[3] M. Van de gaer, "Trailblazers Network in AM," Shadertoy 7fyGzG. [Online]. Available: https://www.shadertoy.com/view/7fyGzG

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