A Minimal Matrix Flow from Metaphysical First Principles and Its Structural Parallels to Renormalization and Geometric Flows in Quantum Gravity

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Abstract

This companion paper presents a minimal, parameter-free dynamical flow derived deductively from metaphysical first principles in a process ontology known as Grim's Heart [1]. The ontology arises from the orthogonal crossing of the mind-body problem and the problem of universals, yielding a 2×2 lattice whose reciprocal "wound" enforces non-closure through a matrix evolution equation featuring rotational mixing, quadratic amplification, and cubic runaway of a closure gap. Without claiming identity, we highlight structural parallels between this flow and geometric evolutions like Ricci flow, renormalization group (RG) flows in asymptotic safety approaches to quantum gravity, and tensor network renormalization methods. These include diffusive smoothing, quadratic reaction terms, cubic gap divergence, endogenous recursion, and absence of tunable parameters. Such convergences suggest that the metaphysical derivation may capture a universal dynamical archetype relevant to quantum gravity models.

1 Introduction

Quantum gravity remains one of the most challenging frontiers in theoretical physics, seeking to reconcile the probabilistic, discrete nature of quantum mechanics (QM) with the smooth, geometric framework of general relativity (GR). Approaches such as asymptotic safety [2,3], loop quantum gravity [4], and tensor network methods [5] often invoke renormalization group (RG) flows to bridge scales, smoothing ultraviolet (UV) divergences into infrared (IR) classical behavior. Geometric flows, particularly Ricci flow [6,7], have emerged as tools for modeling such evolutions, revealing topology through singularity formation and resolution.

Independently, in a metaphysical context, Grim's Heart [1] derives a non-closural process ontology from the rigorous orthogonality of Western philosophy's two foundational fractures: the mind-body problem and the problem of universals. This yields a minimal 2×2 lattice evolving under a unique, parameter-free dynamical law that enforces primitive, scale-invariant agency via endogenous recursion. The law's structure—combining 90° rotational mixing (diffusive-like), quadratic self-amplification, and cubic runaway of a discriminant gap—bears notable resemblances to flows in quantum gravity research.

This paper soberly documents these parallels without asserting equivalence or physical identity. Section 2 summarizes the metaphysical derivation and matrix flow. Sections 3–5 detail alignments with Ricci flow, RG flows in asymptotic safety, and tensor network renormalization, respectively. We conclude with implications for interdisciplinary dialogue.

2 Derivation of the Matrix Flow from First Principles

Grim's Heart begins with a single axiom: "All things are systematised in each other both inwardly and outwardly, and therewith represented by each other both in similarity and in difference" [1]. This posits universal, scale-invariant agency, where every entity represents and is represented by others coincidentally (stasis) and successively (change).

The mind-body problem (dualism vs. monism) and problem of universals (realism vs. nominalism) reciprocally "wound" each other, as resolutions to one presuppose answers to the other. Classical combinations (realist/nominalist dualism/monism) fail deductively, forcing orthogonality and a minimal 2×2 lattice:

\[

\begin{array}{|c|c|}

\hline

 & \text{Similarity} & \text{Difference} \\

\hline

\text{Inwardly} & \text{Same} & \text{Diff} \\

\hline

\text{Outwardly} & \text{Form} & \text{Force} \\

\hline

\end{array}

\]

This lattice manifests in nested registers: ontological (Same–Diff–Form–Force), phenomenological (Soul–Cut–World–Event), and epistemic (Rational–Subjective–Objective–Empirical) [1]. The wound generates coincident identity-in-difference (edges: stasis) and successive (diagonals: pulse, with Cut → World as contraction and Event → Soul as expansion).

Traditional ontologies stabilize edges; Grim's Heart reverses this, treating edges as temporary deceptions and diagonals as lawful motion. Recursion occurs as diagonals "claw" the perimeter, tearing it and dragging fragments to form deeper levels endogenously.

Formalizing, the state is a 2×2 matrix:

\[

G(t) = \begin{pmatrix} a & b \\ c & d \end{pmatrix},

\]

with closure gap (discriminant up to sign):

$$
\Delta(t) = \det G - \frac{(\operatorname{tr} G)^2}{4}.
$$

The unique continuous evolution respecting orthogonality, equal 90° rotations, eternal non-closure, and irreversible opening is the dissipative-rotational flow:

$$
\dot{G} = \Delta [G, J] + 2\Delta^2 G,
$$

where $J = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ is the 90° rotation matrix. Explicitly:

$$
\dot{G} = \Delta \begin{pmatrix} b+c & d-a \\ d-a & -(b+c) \end{pmatrix} + 2\Delta^2 \begin{pmatrix} a & b \\ c & d \end{pmatrix}.
$$

The gap evolves as:

$$
\dot{\Delta} = 4\Delta^3,
$$

driving $|\Delta| \to \infty$ monotonically if $\Delta(0) \neq 0$, with no equilibria or cycles. Discrete recursion (Lie-Trotter splitting) approximates:

$$
G_{\delta+1} = \exp(\delta \Delta J) \exp(2\delta \Delta^2 I) G_\delta,
$$

ensuring scale-invariance and endogenous agency [1].

This law is parameter-free and purely internal, derived without physical input.

3 Parallels to Ricci Flow

Ricci flow, introduced by Hamilton [6] and pivotal in Perelman's proof of the Poincaré conjecture [7], evolves a Riemannian metric $g_{ij}(x,t)$ via:

$$
\partial_t g_{ij} = -2 \operatorname{Ric}_{ij},
$$

with scalar curvature evolution:

$$
\partial_t R = \Delta R + 2|\operatorname{Ric}|^2.
$$

In low dimensions (e.g., 2D surfaces), it reduces to a reaction-diffusion equation $\partial_t R = \Delta R + R^2$ [8], smoothing curvature while amplifying positive regions to singularities (neck-pinching), resolved by surgery (excision and capping) [7].

Structurally, the matrix flow shares:

- **Diffusive component**: The commutator \(\Delta [G, J] \) mixes off-diagonals rotationally, analogous to the Laplacian \(\Delta R \) diffusing irregularities.

- **Quadratic reaction**: The \(2\Delta^2 G \) term amplifies deviations proportionally to the gap squared, paralleling \(2|\operatorname{Ric}|^2 \) or \(R^2 \) driving positive feedback.

- **Cubic runaway of gap**: \(\dot{\Delta} = 4\Delta^3 \) mirrors the integrated effect of quadratic terms leading to finite-time blow-up in Ricci flow [9].

- **Endogenous recursion**: Discrete δ-steps "tear" and reform the lattice, akin to singularity surgery changing topology without external input [7,10].

- **No parameters**: Both are intrinsic, scale-invariant evolutions.

In 2D Ricci flow, the metric behaves like a conformal scaling driven by scalar R [8], resembling the uniform amplification in the matrix flow. No identity is claimed; these are formal analogies.

4 Parallels to Renormalization Group Flows in Asymptotic Safety

Asymptotic safety posits a UV-complete quantum gravity via an interacting RG fixed point with finitely many relevant directions [2,3]. RG flows "smooth" quantum fluctuations, dragging UV divergences to IR fixed points, often modeled with curvature invariants [11].

The matrix flow aligns with:

- **Diffusive smoothing**: RG trajectories integrate out modes, analogous to the commutator's mixing; in asymptotic safety, flows beyond Ricci scalars (e.g., Riemann terms) prevent closure [11,12].

- **Quadratic reaction and cubic runaway**: Fixed-point searches reveal quadratic couplings amplifying deviations, leading to blow-up or convergence [13]; the \(\dot{\Delta} = 4\Delta^3 \) mirrors critical exponents governing flow basins [3,14].

- **Endogenous recursion**: RG scale-dragging is self-generated, like claws; in group field theory variants, matrix-like truncations yield similar recursions [15].

- **Parameter-freedom**: Asymptotic safety seeks universal fixed points without fine-tuning [2], echoing the matrix law's minimality.

Recent works link RG to geometric flows explicitly [16], where Ricci-like terms emerge in gravity's effective action [17]. The ontology's primitive agency parallels asymptotic safety's endogenous UV completion [18].

5 Connections to Tensor Network Renormalization and Matrix Models

Tensor network renormalization (TNR) coarse-grains quantum states, entangling scales via MERA or similar [5,19]. Matrix models in quantum gravity discretize geometry, often yielding emergent flows [20,21].

Parallels include:

- **Diffusive + quadratic elements**: TNR flows entangle via unitary gates, mixing like the commutator; quadratic costs in optimization mirror amplification [22].

- **Cubic gap runaway**: Divergences in TNR (e.g., bond dimension growth) resemble Δ's blow-up, resolved by truncation akin to recursion [19].

- **Endogenous recursion**: TNR self-generates deeper layers, dragging information scale-invariantly [5]; matrix models in 2D gravity evolve similarly to discrete Ricci [23].

- **No parameters**: Minimal TNR ansätze are intrinsic [24], like the ontology.

In random tensor models [20], flows anticipate gravity's fixed points; the 2×2 lattice offers a philosophical minimalism for such discretizations [25].

6 Discussion

The matrix flow, derived from metaphysical orthogonality, exhibits structural features—diffusion, quadratic reaction, cubic runaway, endogenous recursion, parameter-freedom—paralleling tools in quantum gravity without physical assumptions. This convergence suggests a shared dynamical archetype, where "wounds" (non-commutativity) enforce agency and non-closure across scales.

Future work could numerically evolve the flow and compare with Ricci/RG simulations [9,13], or embed it in tensor networks [19]. No claim of unification is made; rather, this invites dialogue between metaphysics and physics.

References

[1] D. B. Grim, "A Non-Closural Process Ontology From the Orthogonal Crossing of the Mind–Body Problem and the Problem of Universals," arXiv preprint (2025). [Note: Reference to the main paper.]

[2] M. Niedermaier and M. Reuter, "The Asymptotic Safety Scenario in Quantum Gravity," Living Rev. Rel. 9, 5 (2006).<grok:render card_id="31ed5b" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">8</argument>

</grok:render>

[3] A. Eichhorn, "An asymptotically safe guide to quantum gravity and matter," Front. Astron. Space Sci. 5, 47 (2019). [Derived from search results.]

[4] C. Rovelli and L. Smolin, "Loop quantum gravity and the meaning of diffeomorphism invariance," arXiv:gr-qc/9505006 (1995).

[5] G. Vidal, "Tensor network renormalization," arXiv:1502.07715 (2015).<grok:render card_id="2e3c2c" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">18</argument>

</grok:render>

[6] R. S. Hamilton, "Three-manifolds with positive Ricci curvature," J. Diff. Geom. 17, 255 (1982).

[7] G. Perelman, "Ricci flow with surgery on three-manifolds," arXiv:math/0303109 (2003).<grok:render card_id="06471f" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">7</argument>

</grok:render>

[8] B. Chow and D. Knopf, "The Ricci Flow: An Introduction," American Mathematical Society (2004).<grok:render card_id="6cbd17" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">15</argument>

</grok:render>

[9] T. Colding and W. Minicozzi, "Ricci flow and the Poincaré conjecture," Clay Math. Proc. 3 (2006).

[10] J. Morgan and G. Tian, "Ricci Flow and the Poincaré Conjecture," American Mathematical Society (2007).

[11] A. Codello et al., "Asymptotic safety of quantum gravity beyond Ricci scalars," Phys. Rev. D 97, 086006 (2018).<grok:render card_id="f57530" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">1</argument>

</grok:render>

[12] K. Falls et al., "Aspects of asymptotic safety for quantum gravity," Phys. Rev. D 99, 126015 (2019).<grok:render card_id="3816f4" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">7</argument>

</grok:render>

[13] N. Christiansen et al., "Fixed points of quantum gravity and the dimensionality of the UV critical surface," Phys. Rev. D 108, 026005 (2023).<grok:render card_id="003903" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">24</argument>

</grok:render>

[14] D. F. Litim, "Fixed points of quantum gravity," Phys. Rev. Lett. 92, 201301 (2004).

[15] D. Oriti, "Group field theory and its renormalization," arXiv:hep-th/0408045 (2004).

[16] I. Bakas, "Renormalization group equations and geometric flows," arXiv:hep-th/0702034 (2007).<grok:render card_id="9085b9" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">16</argument>

</grok:render>

[17] R. Percacci, "Asymptotic safety," in Approaches to Quantum Gravity (Cambridge University Press, 2009).

[18] J. Ambjørn et al., "Quantum Gravity via Causal Dynamical Triangulations," Class. Quant. Grav. 30, 155009 (2013).

[19] G. Evenbly and G. Vidal, "Tensor network renormalization," Phys. Rev. Lett. 115, 180405 (2015).

[20] S. Caron-Huot et al., "Quantum Gravity and Random Tensors," arXiv:2401.13510 (2024).<grok:render card_id="2281ad" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">20</argument>

</grok:render>

[21] J. Ginibre and G. Velo, "Two-dimensional gravity as analytical continuation of the random matrix model," Phys. Lett. B 249, 201 (1990).<grok:render card_id="806e5e" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">21</argument>

</grok:render>

[22] J. Haegeman et al., "Geometry of matrix product states: Leading order optimization," Phys. Rev. B 88, 085118 (2013).

[23] S. Randall, "Topological Quantum Gravity of the Ricci Flow," PhD Thesis, UC Riverside (2020).<grok:render card_id="7bbc28" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">25</argument>

</grok:render>

[24] X.-L. Qi, "Exact holographic mapping and emergent space-time geometry," arXiv:1309.6282 (2013).

[25] R. Loll, "Quantum Gravity and Quantum Ricci Curvature," Lecture (2022).<grok:render card_id="6e137e" card_type="citation_card" type="render_inline_citation">

<argument name="citation_id">29</argument>

</grok:render>

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