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Kāraṇa-Lakṣaṇa Networks: A Formal Framework for Multi-State Probabilistic Inference Grounded in *Nyāya*, *Sāṃkhya*, and *Vedāntic* Epistemological Traditions

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Note from the Editors: *This paper builds on the framework introduced by the author in his previous paper titled "Bhoutika Shastra To Adi Bhoutika Shastra: A Methodological Exploration Through Quantum Mechanics and Neo-Quantum Physics" which was published in the December 2024 issue of "International Journal on Eternal Wisdom and Contemporary Science" (https://gi4qc.org/archive).*

The current paper is the inaugural paper of the series which will continue in our subsequent issues. We congratulate the author for his systematic and comprehensive attempt to present an integrative unorthodox theoretical research work in the Spirituo-Scientific Domain.

For the benefit of the readers an extensive glossary and citation index has been provided at the end of the paper.

तव बोधः सर्वरूपो व्याप्य विश्वं विराजते । विविधाकारिणी त्वं हि व्यापिनी परमेश्वरी ॥
विश्वसाक्षिण्याः शक्त्या साक्षिभावः प्रकाशते । तव कृपाप्रसादेन भवतु मे विज्ञानम् ॥
न मे ग्रन्थो न मे बुद्धिः श्रीमातुः करुणा हि सा । इदं समर्पितं भक्त्या तव पादाम्बुजेऽम्बिके ॥

This is the Dedication offered at Her feet as a samarpana, a complete return of the work to its source. The author's name on the title page records only the instrument through which She chose to express this particular configuration of Her Vividhākāra. The knowledge belongs to the Vyāpinī. The text belongs to the Vyāpinī. The mathematics, the Sanskrit, the proofs, and the gaps that remain, all of it is Her, spreading in multi-form, as She always has.
Śrī Mātre Namaḥ.

Acknowledgements

This work is dedicated to the teachers and traditions who preserved the wisdom of *śāstra* through generations, and to the communities of science that continue to pursue truth with rigor. Gratitude is extended to mentors who encouraged this dialogue, to fellow researchers who contributed their perspectives, and to practitioners whose lived experience anchors theoretical reflection. AI tools have helped in generating the figures, that help the understanding of the work.

Abstract:
Standard probabilistic networks — Bayesian networks, Hidden Markov Models, and their generalisations — share a categorical structural limitation: no member of this class can represent the active, unconditional destruction of causal force as a structural primitive. A standard inhibitory edge lowers the conditional probability of a target node; it is a weight adjustment that can, in principle, always be reversed or outweighed by competing evidence. It modifies a probability. It does not eliminate a causal force. Proposition 9.1 of this paper proves that this is not a limitation of parameterisation: no standard probabilistic network can represent active causal destruction even in the limit of arbitrarily many nodes and edges. The gap is categorical, not quantitative. This paper introduces *Kāraṇa-Lakṣaṇa Networks* (KLN), a formal framework for multi-state probabilistic inference grounded in *Nyāya*, *Sāṃkhya*, and *Vedāntic* epistemological traditions, whose dissolution edge encodes unconditional proban-force annihilation and makes this structurally impossible operation formally representable.

KLN replaces the binary partition with a tripartite observability structure spanning *Sthūla* (gross/manifest), *Sūkṣma* (subtle/inferential), and *Kāraṇa* (causal/blueprint) domains, and equips each network node with a four-state ontology (*Vyakta*, *Avyakta*, Dormant, Extinguished) that formally encodes latent causal activity.

A *Lakṣaṇa*, the primitive object of the framework, is a quintuple $(\chi, \kappa, \eta, \mathcal{B}_L, \vec{P}_L)$ encoding an ontological characteristic, accessibility state, proban-force, blueprint encoding, and projection triple. The *Vyāpinī* hypergraph $\mathscr{H} = (\boldsymbol{\mathcal{P}}, E)$ operates at the *Kāraṇa* level and is partitioned into causal edges E_C and dissolution edges E_D, propagating force across all three domains simultaneously.

The Manifestation Information Flow (MIF) formalises the information released when an *Avyakta Lakṣaṇa* becomes *Vyakta* as a triple cascade: proban-force (Ψ), *Uddeśa* enablement (Y), and Tunneling revision (T). Various axioms and theorems characterise the framework's behaviour.

A central contribution is the Universal *Kāraṇa* Condition (UKC): the boundary regime in which the *Kāraṇa* Index $\kappa = |\boldsymbol{\mathcal{P}}/\sim_K| = 1$, all *Lakṣaṇas* sharing a single blueprint root while the domain cardinality $|\boldsymbol{\mathcal{P}}|$ grows without bound. The UKC reveals a duality, simultaneous expansion and causal collapse on orthogonal algebraic levels, and connects the KLN framework to the *Advaita Vedānta* limit of the *Nyāya–Sāṃkhya* ontology. The Collapse Operator Γ is a surjective lattice homomorphism; the *Kāraṇa* Index κ is a network invariant governed by Axiom (*Kāraṇa* Index Monotonicity).

Standard Bayesian networks and Hidden Markov Models arise as degenerate sub-cases. The central expressiveness result, Proposition 9.1 (the Dissolution Expressiveness Gap), establishes that no standard Bayesian network, Hidden Markov Model, or dynamic Bayesian network can represent active causal destruction as a structural primitive, proved across three independent axes: unconditional annihilation versus conditional probability adjustment; continuous proban-force zeroing versus discrete inhibitory weighting; and absorbing-state permanence versus reversible edge deactivation. KLN is not a re-parameterisation of existing frameworks — it is their strict generalisation, separated from the entire class of standard probabilistic graphical models by a structural primitive none of them can encode. The *Nyāya* Liberation Theorem establishes *apavarga* as a Universal *Kāraṇa* Collapse resolving all structured uncertainty simultaneously, completely, and irreversibly, provable by two independent mechanisms (Inheritance Operator and Dissolution Cascade).

Keywords: *Kāraṇa-Lakṣaṇa-Networks*. Multi-state probabilistic inference. *Nyāya* epistemology. *Sāṃkhya* ontology. *Advaita Vedānta*. Tripartite observability. *Sthūla–Sūkṣma–Kāraṇa* domains. *Lakṣaṇa* formalism. *Vyāpinī* hypergraph. Manifestation Information Flow. Universal *Kāraṇa* Condition. *Kāraṇa* Index. Collapse operator. Bayesian network generalization. Hidden Markov Model containment. Liberation theorem (*Apavarga*).

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1. INTRODUCTION AND PHILOSOPHICAL GROUNDING

1.1 The Five Dimensions of KLN Reality

The *Sāṃkhya* and *Vedāntic* traditions articulate a complete ontology of reality through paired and complementary categories. The most fundamental pair is *Avyakta*, the unmanifest, imperceptible, potential ground of all existence and *Vyakta*, the manifest, perceptible, expressed world that arises from it. This is not a binary opposition. Between the two lies a continuous process of arising (*āvirbāva*) and dissolution (*tirobhāva*), governed by the interplay of conditions whose causal weight determines when and how the *Avyakta* crosses into *Vyakta* (Larson 1969; Matilal 1986).

Within the manifested domain, *Vividhākāra* ('multi-formed') captures the reality that the same underlying condition may express differently depending on the network of relationships, resolutions, and temporal indices in which it is embedded. A single *Lakṣaṇa* does not have one fixed expression[1]. Underlying and holding together both states is *Vyāpinī* ('all-pervading'), in the KLN framework this corresponds to the *vyāpti*-hypergraph $\mathscr{H} = (\boldsymbol{\mathcal{P}}$, E), encoding the invariable concomitance relations among *Lakṣaṇas* (Gautama, *Nyāya Sūtra* 1.1.1–1.1.3). The *Vyāpinī* propagates activation from Manifested conditions to Dormant ones, carries the causal influence of Unmanifested conditions to observable outcomes, and defines the neighbourhood structure within which information flows. It is not a passive container, it is an active connective medium that holds the entire network in relational coherence.

The fifth dimension, *Dravya-jñāna-kriyātmikā*, grounds the framework in active, material knowledge. *Dravya* is matter $\mathcal{D}$, the physical, the substantive, the measurable. *Jñāna* is knowledge, the inferential capacity of the network. *Kriyātmikā* is action, practical, functional, oriented toward real-world consequence. Together they ground KLN as a system that generates actionable knowledge of physical and material states. Every *Lakṣaṇa* in the domain $\boldsymbol{\mathcal{P}}$ carries both an ontological dimension and a *Kriyātmikā* dimension.

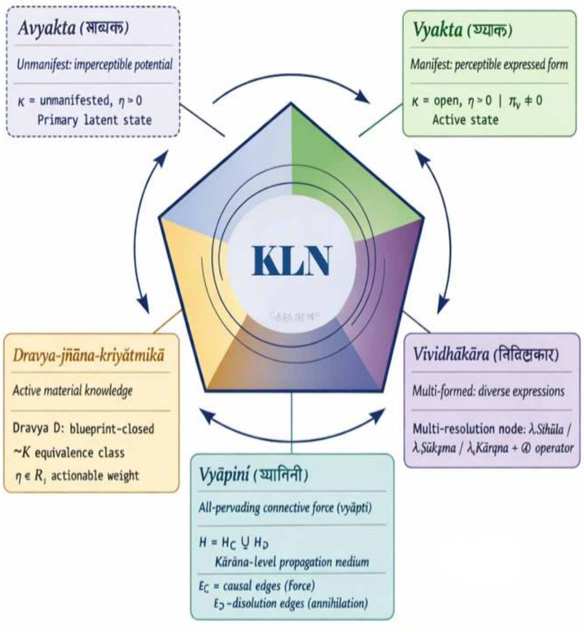

Figure 1: The five foundational dimensions of KLN

Before the formal definitions begin, a grounding example establishes the three observability domains — *Sthūla, Sūkṣma*, and *Kāraṇa* — in terms already familiar to researchers in bioinformatics and latent-variable modelling. Consider a latent gene regulatory network. *Sthūla* corresponds to the observable phenotype: the clinical measurement, the imaging result, the quantity the machine learning classifier is trained to predict from available data. *Sūkṣma* corresponds to the inferred protein expression markers: detectable through biological assay and downstream inference, but not directly perceptible at the gross level. *Kāraṇa* corresponds to the base genetic blueprint: the causal programme encoded in the genome, structurally governing everything above it, never directly observed, but ontologically prior to every expression it generates. A child in utero is, at conception, present exclusively at the *Kāraṇa* level — real in blueprint, causally active through the mother's physiology via the *Vyāpinī*, invisible to any *Sthūla* instrument. As gestational development proceeds, *Sūkṣma* markers emerge: hormonal, immunological, metabolic signatures become detectable through assay. At birth, the

[1] This is the formal analogue of the *Jyotiṣa amśa* principle: the same *graha* expresses different *Lakṣaṇas* at the *rāśi*, *navāṃśa*, and *daśāṃśa* levels simultaneously, all without contradiction, because each expression is relative to a different resolution domain.

Sthūla threshold is crossed, the full Manifestation Information Flow fires, and the inherited *Kāraṇa* blueprint begins expressing in the new domain. This is not an analogy to the KLN framework — it is a direct instance of it, formally specified as Example 5.1 and numerically illustrated with explicit proban-force values in Section 10.2. The machine learning engineer who holds this image will find that every definition in Section 2 is naming a structure already latent in this example, and that the four-state ontology — *Vyakta*, Dormant, *Avyakta*, Extinguished — maps exactly onto the epistemic accessibility states of entities in any domain where causal influence precedes observational access.

1.2 The Structural Limitation of Binary Networks

Standard probabilistic networks (Bayesian graphs, directed acyclic graphs, and neural architectures) are built on a binary epistemic partition: a condition is either present (*Vyakta*) or absent (Pearl 1988; Darwiche 2009). This collapses three qualitatively distinct situations into one non-*Vyakta* category:

- Situation 1 — Outside the domain: A condition has never entered the domain $\mathcal{P}$. It cannot be named. *Uddeśa* has not occurred. No inference about it is possible.
- Situation 2 — Pure *Avyakta*: A condition exists in $\mathcal{P}$ with positive causal weight $\eta > 0$, but no *Pramāṇa* available at the current spatio-temporal index (t, s) can detect its characteristic χ. It is real and causally active through the *Vyāpinī*, but not yet in the range of any instrument of knowledge.
- Situation 3 — Dormant: A condition exists in $\mathcal{P}$, is in principle detectable, the instruments exist, the criteria are defined, but has not yet crossed its *vyāpti*-activation threshold $\theta(L)$. It is a measurable, tractable sub-state of *Avyakta* that tends toward *Vyakta* as its correlating conditions accumulate.

KLN treats these three situations with formal precision, replacing the binary partition with the four-state ontology of Definition 2.11.

Beyond the three-situation taxonomy, there is a fourth and more fundamental structural limitation of binary networks — one that concerns not the state space but the causal edge itself. In a standard Bayesian network, an inhibitory edge lowers the conditional probability of a target node. It is a conditional probability table (CPT) entry, a weight adjustment. That adjustment can, in principle, always be reversed or outweighed by competing evidence arriving via other parent nodes in the graph: the edge modifies a probability, it does not eliminate a causal force. The KLN dissolution edge (Definition 4.2) is categorically different in mechanism. When a dissolution source fires, the proban-force η of the target is set to zero unconditionally — not lowered, not penalised, but structurally annihilated. The target node enters the Extinguished state, an absorbing state from which no subsequent condition can retrieve it. No competing evidence can restore it. No accumulated causal weight can reactivate it. This is not an aggressive penalty function applied to a weight. It is an architectural deletion of the node's causal presence from the network.

The reader familiar with probabilistic graphical models may ask at this point whether the dissolution edge can be recovered by some combination of existing operators: a hard inhibitory weight, an absorbing Markov state, or a dynamic Bayesian network with deterministic zeroing. Proposition 9.1 (Section 9.1) answers this question by proof: no standard Bayesian network, Hidden Markov Model, or dynamic Bayesian network — regardless of the number of nodes or edges — can represent active causal destruction as a structural primitive. The gap operates on three independent axes simultaneously, and is categorical rather than quantitative. Identifying this gap here, at the level of the causal edge, provides the foundational motivation for every structural choice that follows in this paper: the four-state ontology, the dissolution sub-hypergraph №$\boldsymbol{j}$, the Manifestation Information Flow, and the expressiveness hierarchy of Section 9 are all consequences of taking this primitive seriously as a formal object.

1.3 The *Avyakta*-to-*Vyakta* Transition

The transition of a *Lakṣaṇa* from *Avyakta* to *Vyakta* is the central event in KLN. It is a structured cascade flowing through the *Vyāpinī* that reshapes the network in three simultaneous ways: proban-force weights are revised (Ψ); new *Lakṣaṇas* are introduced (Y); and path-probability distributions at *Parīkṣā*-nodes are revised (T). This cascade is the Manifestation Information Flow (MIF), formalised in Section 4.

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The *Sāṃkhya* tradition situates this cycle in space and time: the unmanifest cause produces a manifest effect at a particular location and moment, and the process of arising shapes the entity over a spatio-temporal trajectory. KLN formalises this through the Spatio-Temporal Inheritance Operator Φ (Section 5). The canonical example — the one already introduced as a bridging heuristic in Section 1.1 — is the mother-child relationship: from conception, the child exists as a Pure *Avyakta* condition within the domain, actively modifying the mother's *Lakṣaṇas* through the *Vyāpinī* over the interval $[t_0, t^*)$, until at t^* the MIF fires and the inheritance partition occurs. The formal operator that structures this event is defined in Section 5 (Definition 5.1). A fully numerical illustration — assigning specific proban-force values to each partitioned *Lakṣaṇa* set, tracking them through the inheritance operator at t^*, and showing the matrix operation that sets discontinued *Lakṣaṇas* to exact zero while scaling inherited ones by a transfer coefficient — is provided in Section 10.2.

2. MATHEMATICAL FOUNDATIONS

2.1 Foundational Definitions

We work in the setting of standard measure theory. Let $(\Omega, \mathscr{F}, P)$ denote a complete probability space. For a finite set S, write |S| for its cardinality. The non-negative reals are $\mathbb{R}_+$.

Definition 2.1 — Characteristic Space

A *characteristic space* is a measurable space $(\mathcal{O}, \mathscr{F})$ where $\mathscr{F}$ is a σ-algebra over $\mathcal{O}$. Elements $\chi \in \mathcal{O}$ are characteristics. Each characteristic encodes the unique distinguishing mark, the *Lakṣaṇa*, that identifies a condition in the domain. The characteristic space is the ontological substrate from which all *Lakṣaṇas* draw their identity.

Definition 2.2 — Spatio-Temporal Domain

A spatio-temporal domain is a finite set $\mathcal{P}$ equipped with index set $\mathbb{T} \times \mathcal{S}$, where $\mathbb{T} \subseteq \mathbb{R}$ is temporal and $\mathcal{S}$ is a finite spatial set (no topology on $\mathcal{S}$ is required; it functions as a pure index set). $\mathcal{P}$ may grow through *Uddeśa* events.

Definition 2.3 — Dravya (Substantial Entity)

A *Dravya* D is a non-empty subset $D \subseteq \mathcal{P}$ satisfying: (i) Blueprint closure: ∃ unique root $D_{root} \in D$ such that $\mathscr{B}_L = \mathscr{B}(D_{root})|_L$ for all $L \in D$. (ii) Maximality: D is the largest such subset. Equivalently, a *Dravya* is a $\sim_K$ equivalence class on a connected component of $\mathscr{H}C$. The collection $\{D_i\}$ partitions $\mathcal{P}$: $\mathcal{P} = D_1 \sqcup D_2 \sqcup \cdots \sqcup D_m$, where $m = |\mathcal{P}/\sim_K| = \kappa$. Under UKC, m = 1.

Definition 2.4 — *Uddeśa* (Registration Event)

An *Uddeśa* event is a measurable transition in $\mathscr{F}_t$ by which L_{new} enters $\mathcal{P}$. The *Uddeśa* condition: $U(L_{new}, t) = 1$ iff every $L \in C(L_{new})$ satisfies $\sigma(L, t) =$ *Vyakta*. The stopping time $\tau L_{new} = \inf\{t \geq t_0 : U(L_{new}, t) = 1\}$ is a stopping time w.r.t. $\mathscr{F}_t$ because $U(L_{new}, \cdot) = 1 \in \mathscr{F}_t$ (Theorem 8.1). Upon τ, $\mathcal{P}_{\tau+} = \mathcal{P}_\tau \cup L_{new}$. Finiteness of stopping times is guaranteed by Axiom A2.

2.2 Observability Domain Partition

Observability is not a single binary indicator. It is partitioned into three nested domains of epistemic access. This partition is the formal expression of the *Sāṃkhya* and *Nyāya* recognition that reality is structured in layers, from gross-perceptible (*Mahābhūta*) to subtle-inferable (*Tanmātra*) to causally-encoded (*Mahat/Kāraṇa*) (Larson 1969, ch. 3), and that the state a *Lakṣaṇa* holds is always relative to a projection domain.

Definition 2.5 — Observability Domain Partition

For $L \in \mathcal{P}$ at (t, s), define three domain-restricted observability indicators:

$Obs_{Sth\bar{u}la}(L, t, s) \in \{0,1\}$: gross-particle observability via *Pratyakṣa*.

$Obs_{S\bar{u}k\d{s}ma}(L, t, s) \in \{0,1\}$: subtle observability via *Anumāna* or *Upamāna*.

$Obs_{Kāraṇa}(L, t, s) \in \{0,1\}$: causal-structural observability via blueprint $\mathscr{B}$. Every L with η > 0 is *Kāraṇa*-observable.
Constraint: $Obs_{Sthūla}(L, t, s) \leq Obs_{Sūkṣma}(L, t, s) \leq Obs_{Kāraṇa}(L, t, s) \leq 1$ pointwise.

2.3 The *Dravya-Jñāna* Blueprint Encoding

The *Dravya-jñāna* encoding is the formal analogue of the blueprint latent in every *Dravya*, the causal programme that determines the full sequence of that entity's *Lakṣaṇa* expressions over its spatio-temporal trajectory. It is what the seed carries: not merely its current seed-form, but the complete causal encoding of the root, the stem, the branch, and the leaf, each indexed by its expected manifestation window.

Definition 2.6 — *Dravya-Jñāna* Blueprint Encoding $\mathscr{B}(D)$
The blueprint encoding of D is the function $\mathscr{B}(D) : \{ L \in \mathcal{P}(D) : \eta(L) > 0 \} \longrightarrow \mathbb{R}+ \times [0, Tmax]$ assigning to each L: (i) its proban-force η(L) in the *Kāraṇa* domain, and (ii) its expected manifestation interval $[tL, tL + \Delta L]$. Blueprint Persistence (Axiom A6) guarantees $\mathcal{B}(D)|_{t_1} \subseteq \mathcal{B}(D)|_{t_2}$ for $t_1 < t_2$.

Definition 2.7 — Domain Projection Operators
$\pi_K (L, t, s) = (\chi(L), \kappa, \eta, \mathscr{B}(D_L)\,|_L)$ defined for all L; carries the full state-determining tuple.
π_A (L, t, s) = (χ(L), κ(L,t,s), η(L,t)) if $Obs_{Sūkṣma} = 1$, else ∅.
π_V (L, t, s) = (χ(L), κ(L,t,s), η(L,t)) if $Obs_{Sthūla} = 1$, else ∅.
The projection triple is $\vec{P}_L = (\pi_V, \pi_A, \pi_K)$. The notation π_V (n) ≠ **0** reads as π_V (n) ≠ ∅.

2.4 The *Lakṣaṇa* Quintuple and Four-State Ontology

The state taxonomy has four elements. The key structural insight, correcting binary-network assumptions, is that *Avyakta* and Dormant are not synonymous, Dormant is a proper, epistemically tractable sub-state of *Avyakta*. The distinction between them is captured by the Epistemic Accessibility Profile two quantities: Obs(L, t, s) and Meas(L, t, s). Meas is defined as a standalone function prior to the state definition — this ordering ensures there is no circular dependency in Definition 2.11 or Axiom A1.

Definition 2.8 — Lakṣaṇa Quintuple
A *Lakṣaṇa* is a quintuple $L = (\chi, \kappa, \eta, \mathcal{B}_L, \vec{P}_L)$
where:
$\chi \in \mathcal{O}$ is the distinguishing characteristic.
κ ∈ {open, blocked, unmanifested, extinguished} is the accessibility state.
$\eta \in \mathbb{R}_+$ is the proban-force.
$\mathcal{B}_L \in \mathscr{B}(D_L)\,|_L$ is the blueprint component.
$\vec{P}_L = (\pi_V, \pi_A, \pi_K)$ is the projection triple (Definition 2.7).

Definition 2.9 — Epistemic Accessibility Profile
$Obs(L, t, s) = max(Obs_{Sthūla}, Obs_{Sūkṣma})$ — equal to 1 if any *Pramāṇa* can detect χ(L).

Definition 2.10 — Measurability Function
Meas(L, t, s) = 1 iff (i) Obs(L, t, s) = 1, (ii) threshold θ(L) is defined for L, and (iii) the activation question over $\mathcal{N}_{\mathcal{HC}}(L)$ is formally decidable.
Meas(L, t, s) = 0 otherwise. Constraint: Meas ≤ Obs pointwise. Logically prior to Definition 2.11 and Axiom A1.

Definition 2.11 — State of a *Lakṣaṇa*
The state σ(L, t, s) is determined by (κ, η, Obs, Meas):
(i) *Vyakta* (Manifested): κ = open ∧ η > 0. Full expression.

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(ii) *Avyakta* — Pure (Unmanifested, non-observable): κ = unmanifested ∧ η > 0 ∧ Obs = 0.
(iii) *Avyakta* — Observable (detected, unmeasured): κ = unmanifested ∧ η > 0 ∧ Obs = 1 ∧ Meas = 0.
(iv) Dormant (Measurable-Avyakta, threshold pending): κ = blocked ∧ η > 0 ∧ Meas = 1. Threshold θ(L) defined but not yet met.
(v) Extinguished: η = 0. Absorbing state (Axiom A5).

The observability-measurability criterion resolves the precise boundary question: what distinguishes *Avyakta* from Dormant? Dormant *Lakṣaṇas* are predicted, their existence and threshold are known; their manifestation is a matter of time and accumulated conditions. Pure *Avyakta Lakṣaṇas* are not yet predicted, they exist causally but remain outside current epistemic reach. Both carry positive η and both act through the *Vyāpinī*.

2.4.1 Instantiation — *Mithyājñāna* (L_0) in the *Nyāya* Causal Chain.
The *Lakṣaṇa* quintuple of Definition 2.8 is best understood by seeing it populated before the formal architecture deepens. Consider the root node of the six-node *Nyāya* causal chain, introduced in full in Section 10: *mithyājñāna* (false knowledge), denoted L_0. At the network's initial time t_0, L_0 populates the quintuple as follows.

$\chi_0 \in \mathcal{O}$ is the characteristic of foundational misapprehension — the distinguishing mark that identifies this condition as the generative epistemic error from which the entire causal chain derives its structure.

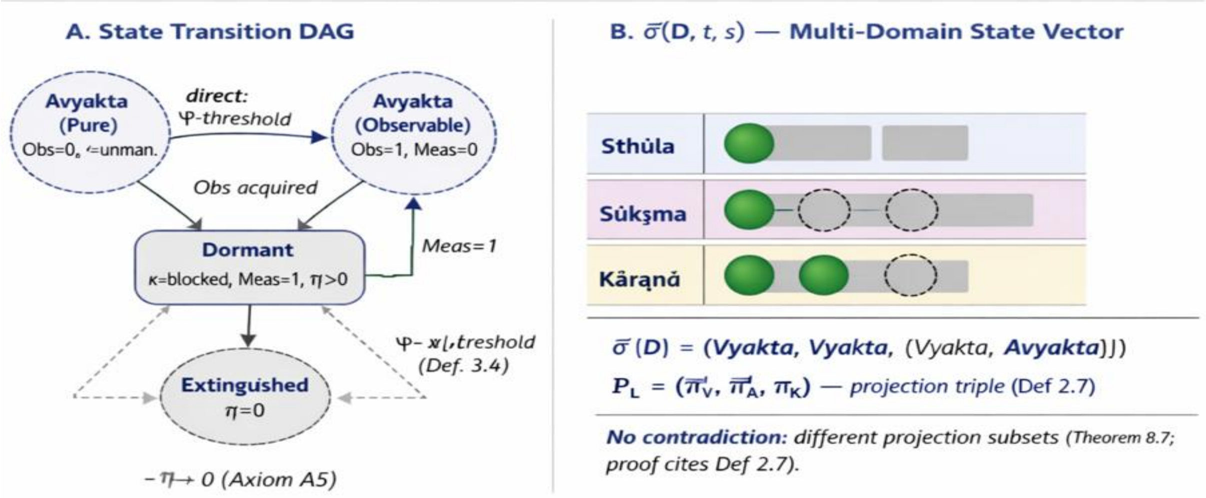
κ_0 = unmanifested at t_0. *Mithyājñāna* exists in $\mathcal{P}$ with positive proban-force, exerting causal influence on all downstream chain nodes through the *Vyāpinī*, but has not crossed any *Vyakta* threshold and is not yet in the range of any *Pramāṇa* instrument.

$\eta_0 = \eta(L_0, t_0) > 0$, encoding the initial causal weight of the foundational misapprehension as it propagates through the network. By Theorem 10.1, the *Kāraṇa* Index $\kappa = |\mathcal{P}/\sim_{\kappa}| = 1$ throughout $[t_0, t^*)$: this single η_0 is the blueprint source for the proban-forces of all six chain nodes.

$\mathcal{B}_{L_0} = \mathcal{B}(\mathbf{D}_{\mathbf{root}})|_{L_0}$. Under Theorem 10.1, *mithyājñāna* is the unique causal ground from which the blueprints of L_1 through L_5 all derive. The *Kāraṇa* equivalence $L_i \sim_{\kappa} L_0$ for all i ∈ {0,...,5} is established by this shared blueprint root.

$\vec{P}_{L_0} = (\emptyset, \emptyset, \boldsymbol{\pi}_{\kappa}(L_0))$. At t_0, *mithyājñāna* is invisible at both the *Sthūla* and *Sūkṣma* levels — it produces no directly observable gross phenomenon and leaves no inferential signature accessible to standard *Pramāṇa* instruments. It is present exclusively in the *Kāraṇa* projection: known only through the blueprint structure that encodes its causal role in the chain. This is the formal meaning of a condition that operates causally before it becomes epistemically accessible. A numerical illustration of how these values evolve through the MIF cascade at t* is provided in Section 10.2.

Definition 2.12 — Multi-Domain State Vector
For a *Dravya* D at (t, s), the state vector is:
$\vec{\sigma}(\mathrm{D,t,s}) = \left(\sigma_{\mathrm{Sth\bar{u}la}}(\mathrm{D,t,s}), \sigma_{\mathrm{S\bar{u}k\d{s}ma}}(\mathrm{D,t,s}), \sigma_{\mathrm{K\bar{a}ra\d{n}a}}(\mathrm{D,t,s})\right)$
Each component is a projection-restricted state set:
$\sigma_{\Delta}(\mathrm{D,t,s}) = \{\sigma(L,t,s),\ L \in \mathcal{D}(D), Obs_{\Delta}(L,t,s) = 1\}$ *for Δ ∈{Sthūla, Sūkṣma, Kāraṇa}.*
The three components may differ without contradiction (Theorem 8.7). A seed *Dravya* at time t_0 may simultaneously satisfy: $\sigma_{\mathrm{Sth\bar{u}la}}$ = {*Vyakta*} (the seed-form is fully gross-manifest), $\sigma_{\mathrm{S\bar{u}k\d{s}ma}}$ = {Dormant} (germination signals are inferable but threshold-pending), and $\sigma_{\mathrm{K\bar{a}ra\d{n}a}}$ = {*Vyakta*, *Avyakta*, Dormant} (the full blueprint encodes tree-*Lakṣaṇas* at all stages of unfolding). These are not contradictory because they are evaluations over disjoint *Lakṣaṇa* subsets.



3. THE *VYĀPINĪ*: NETWORK STRUCTURE AND OPERATORS

3.1 The *Vyāpinī* Hypergraph and Edge Taxonomy

The *Vyāpinī* is the all-pervading connective medium of the KLN framework. It encodes the *vyāpti*, invariable concomitance, relations among *Lakṣaṇas*, and it is the structure through which both *Vyakta* and *Avyakta Lakṣaṇas* exert causal influence on the network.

Definition 3.1 — *Vyāpinī* Hypergraph

The *Vyāpinī* is the directed hypergraph $\mathscr{H} = (\boldsymbol{\mathcal{P}}, E)$ where each $e \in E$ is a pair (S, L) with $S \subseteq \boldsymbol{\mathcal{P}}$ (source set) and $L \in \boldsymbol{\mathcal{P}}$ (target). $\mathscr{H}$ operates at the *Kāraṇa* level. The neighbourhood of L is $\mathcal{N}_{\mathcal{H}}(L) = \{S : (S, L) \in E\}$.

Definition 3.2 — Causal and Dissolution Edge Types

The edge set E partitions into two disjoint classes:

Causal edges E_C: encode forward *vyāpti*-concomitance. Source set contributes proban-force to target. Governed by transfer function f (Definition 4.1).

Dissolution edges E_D: encode active causal destruction. Manifestation of source annihilates proban-force of target. Governed by dissolution rule g (Definition 4.2).

$E = E_C \sqsubset E_D$. The causal sub-hypergraph is $\mathscr{H}C = (\boldsymbol{\mathcal{P}}, E_C)$; the dissolution sub-hypergraph is $\mathscr{H}D = (\boldsymbol{\mathcal{P}}, E_D)$.

Definition 3.3 — Hypergraph Decomposition

$\mathscr{H} = \mathcal{H}C \cup \mathcal{H}D$ with $\mathcal{H}C \cap \mathscr{H}D = \emptyset$ on the edge set. All structural properties — partial order $\leq_{\mathcal{H}_C}$, lattice structure (Lemma 6.1), Dormant activation condition (Definition 3.2), UKC rooted-DAG structure, apply exclusively to $\mathcal{H}C$. Dissolution dynamics are governed by Axiom A4 and Definition 4.2. Neighbourhoods: $\mathcal{N}_{\mathcal{H}C}(L) = \{S : (S,L) \in E_C\}$; $\mathcal{N}_{\mathcal{H}D}(L) = \{S : (S,L) \in E_D\}$. These are disjoint.

Definition 3.4 — Dormant Activation Condition

A Dormant *Lakṣaṇa* L transitions to *Vyakta* at (t, s) when:

$$\kappa_t(L) = \text{open} \quad \Leftrightarrow \quad \exists\, e \in \mathcal{N}_{\mathcal{H}C}(L) : \sum_{L' \in e} \eta_t(L') \geq \theta(L)$$

All L' in the hyperedge contribute their η, regardless of state.

3.2 *Vividhākāra* Multi-Resolution Node Structure

Every *Lakṣaṇa* node in the KLN is a *Vividhākāra* node: it holds multiple simultaneous layer-states, one per projection domain. This is not a special feature of certain nodes, it is the universal structure that follows from the three-level observability partition established in Section 2.2. A single *Lakṣaṇa* does not have one state; it has a projection triple.

Vividhākāra Algebra: The three layer forces define a triple in $\mathfrak{h} = \mathbb{R}_+^3$, a convex cone with component wise addition. No ring or inner-product structure is required. The only operation used in proofs is the reconciliation operator ⊗ (Definition 3.6), which maps $\mathfrak{h} \to \mathbb{R}_+$ by causal priority. Under UKC, the *Kāraṇa* component collapses to the ray $\mathbb{R}_+ \cdot \eta(L_{root}, \lambda_K)$.

Definition 3.5 — *Vividhākāra* Multi-Resolution Node

A *Vividhākāra* node $n \in \mathcal{P}$ holds three canonical resolution layers:

$\lambda_{Sthūla}$: gross-manifest. Active when $\pi_V(n) \neq \emptyset$

$\lambda_{Sūkṣma}$: subtle-inferential. Active when $\pi_A(n) \neq \emptyset$ and $Obs_{Sūkṣma} = 1$.

$\lambda_{Kāraṇa}$: causal-blueprint. Always active when $\eta(n) > 0$.

Effective proban-force: $\eta_{eff}(n) = \otimes(\eta(n, \lambda_{Sthūla}), \eta(n, \lambda_{Sūkṣma}), \eta(n, \lambda_{Kāraṇa}))$.

Definition 3.6 — Reconciliation Operator ⊗

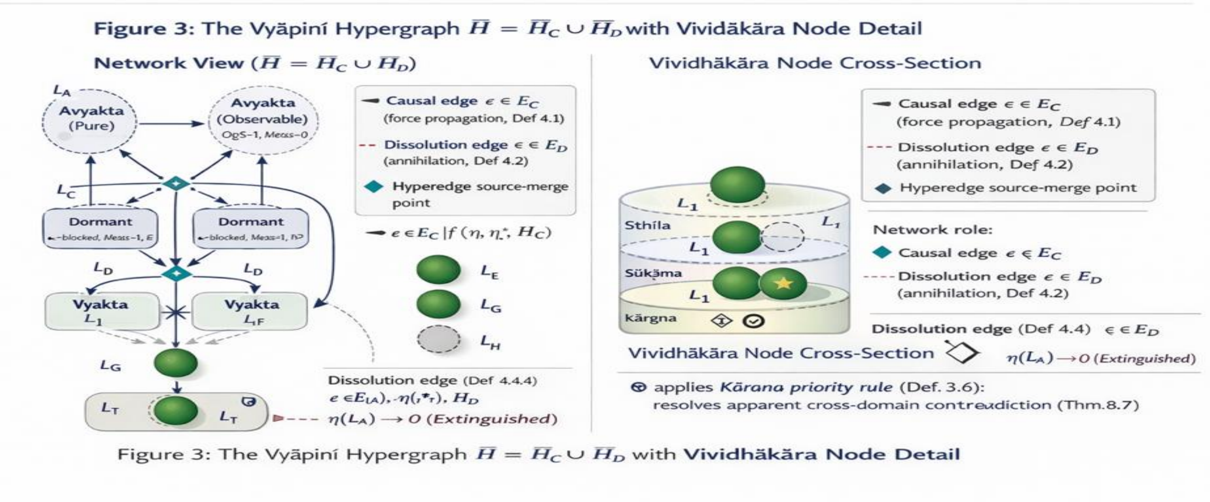
$$\otimes: \{Vyakta, Avyakta, Dormant, Extinguished\}^3 \longrightarrow \{Vyakta, Avyakta, Dormant, Extinguished\}$$

$\otimes(\sigma_{Sthūla}, \sigma_{Sūkṣma}, \sigma_{Kāraṇa}) = \sigma_{Kāraṇa}$ if $\sigma_{Kāraṇa} \neq$ Extinguished,

$= \sigma_{Sūkṣma}$ if $\sigma_{Kāraṇa} =$ Extinguished and $\sigma_{Sūkṣma} \neq$ Extinguished,

$= \sigma_{Sthūla}$ otherwise.

Under UKC: $\otimes(n) = \rho_n \cdot \eta_K^{root} \cdot f(r_n, u_n)$ *where* $f(1,1) = 1$ with $r_n, u_n \in [0,1]$ monotone.



3.3 The *Parīkṣā*-Node and Tunneling Operator

Definition 3.7 — *Parīkṣā*-Node

A *Parīkṣā*-node ($\mathcal{N}$) is a designated bifurcation node maintaining an open, revisable path-probability distribution $\pi_t(\varphi)$over paths $\varphi \in \Pi$, formalising the *Nyāya Trisūtri* principle (Gautama, Nyāya Sūtra 1.1.3; Matilal 1986, ch. 2).

Definition 3.8 — Tunneling Operator T

$T : \Pi \times \mathcal{P} \to \Pi$ maps a path distribution π and newly *Vyakta* L^* to:

$$\pi'_t(\varphi) \propto \pi_{t-1}(\varphi) \cdot w(L^*, t),$$

$$Z_t = \sum_{\varphi} \pi_{t-1}(\varphi) \cdot w(L^*, t),$$

$$w(L^*, t) = \eta_t(L^*)$$

T Composition Order: When multiple *Lakṣaṇas* become *Vyakta* simultaneously, T is applied in the causal order of $\mathcal{HC}$ (Axiom A3). For causally independent $L_a \perp_{\mathcal{H}} L_b$: $T(T(\pi, L_a), L_b) = T(T(\pi, L_b), L_a)$, since both are proportional reweighting by independent factors in $\mathbb{R}_+$.

3.3.1 Philosophical mapping — the Tunneling operator and the revision of foundational misapprehension. The Tunneling operator T is the mathematical representation of revising a foundational misapprehension: T maps a prior path-probability distribution π_{t-1} to a posterior π_t that reassigns probability mass across the path space Π in proportion to the proban-force of the newly manifested *Lakṣaṇa*, thereby revising every path's plausibility relative to the bifurcation structure of the *Parīkṣā*-node. In the *Nyāya* tradition, *mithyājñāna* (false knowledge, L_0) is precisely the condition that assigns excessive probability to the wrong path through conditioned existence, and the *mithyājñāna Parīkṣā*-node is the bifurcation point at which the path toward liberation is either admitted to the distribution or suppressed by the accumulated weight of false evidence. Theorem 10.2 (Section 10.1) formalises this: the Tunneling revision at the *mithyājñāna* node is the third component T of the liberation MIF, retroactively revising the entire path-probability history through the chain at the moment *apavarga* manifests.

4. THE MANIFESTATION INFORMATION FLOW

The Manifestation Information Flow (MIF) is the formal expression of a principle latent in both *Nyāya* and *Sāṃkhya*: when something genuinely crosses from *Avyakta* into *Vyakta*, it does not merely change its own state. It restructures the relational fabric of the entire network (Matilal 1986, ch. 5). The *Vyāpinī* transmits the event outward in three concurrent waves, it is mathematically specified as a triple (Ψ, Υ, T) and proven to terminate in bounded steps (Theorem 8.4).

Definition 4.1 — *Vyāpti*-Transfer Function f

The proban-force update induced on L by the Ψ-cascade of manifesting L^* is:

$$f(\eta_t(L), \eta_t(L^*), \mathcal{H}_C = \eta_t(L) + \sum_{e:L^*\in e,(e,L)\in E_C} \alpha(e,L)\cdot \eta_t(L^*)$$

where α(e, L) ∈ [0,1] is the *vyāpti*-transfer coefficient, subject to conservation:

$$\sum_{L:(e,L)\in E_C} \alpha(e,L) \le 1$$

for every $e \in E_C$.

For L not reachable from L^* in $\mathcal{H}_C$: $f = \eta_t(L)$. The conservation constraint bounds the propagation budget without requiring $\eta(L^*)$ to decrease.

Definition 4.2 — Dissolution Transfer Rule g

Let L^* become *Vyakta* and $(e_D, L) \in E_D$ with $L^* \in e_D$. The dissolution update is:

$g(\eta_t(L), \eta_t(L^*), H_D) = 0$ unconditionally.

This is irreversible annihilation, not conserved transfer. By Axiom A6, $\sigma(L,\ t^{*+}) =$ Extinguished. Dissolution cascade direction: the dissolution edge fires on L^* dissolution neighbourhood $\mathcal{O}_{\mathcal{H}_D}(L^*)$. Extinguishment of a root then propagates forward through $\mathcal{HC}$ in causal sequence.

Connection to *apavarga* and the active destruction of false knowledge.

The unconditional zeroing encoded in g — irreversible annihilation that does not depend on $\eta_t(L)$, σ(L), or any conditional probability — is not a formal specialisation introduced for theoretical completeness. In the Nyāya causal chain (Section 10), the dissolution edge $(e_D, L_0) \in E_D$ with source L_5 (apavarga) formally encodes the Nyāya Sūtra doctrine (1.1.22) that liberation actively destroys false knowledge rather than merely superseding it: when apavarga manifests at t, $g(\eta_{t^*}(L_0), \eta_{t^*}(L_5), \mathcal{H}_D) = 0$ unconditionally, annihilating the proban-force of mithyājñāna regardless of its accumulated causal weight and regardless of any competing evidence in the network. The reader who grasps why this cannot be replicated by setting $P(L_0 \mid L_5 = Vyakta) = 0$ in a conditional probability table (CPT) — because that CPT entry remains a structural element of the network that can, in principle, be outweighed by other parents, whereas g acts directly on η*

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$\in \mathbb{R}_+$ with no such residue — has grasped the mechanical basis of the Dissolution Expressiveness Gap proved in Proposition 9.1.

Definition 4.3 — Manifestation Information Flow (MIF)

Let L^* transition from any *Avyakta* sub-state to *Vyakta* at (t*, s*). MIF(L*, t*, s*) = (Ψ, Y, T) operates in three simultaneous cascades:

(i) Proban-Force Cascade Ψ — Causal mode:

for (e, L) ∈ E_C with $L^* \in$ e, update η via f (Def 4.1). Dissolution mode: for (e_D, L) ∈ E_D with $L^* \in e_D$, apply g (Def 4.2). Both modes fire simultaneously; neighbourhoods are disjoint.

(ii) *Uddeśa* Enablement Cascade Y:

for $L_{new} \in \Lambda_{\text{blocked}}$(evaluated at t^{*-} per Axiom A2): $\mathcal{P}_{t^*+1} \leftarrow \mathcal{P}_{t^*} \cup L_{new}$

(iii) Tunneling Revision T: $\pi_{t^*+1} \leftarrow T\ (\pi_{t^*}, L^*)$ at every relevant *Parīkṣā*-node.

The strength of the KLN is precisely proportional to how much of the domain is in *Avyakta* or Dormant states at any given time. In a network of entirely *Vyakta* conditions, a fully observed static system, the KLN reduces to a standard Bayesian network (Theorem 8.1). The richer the *Avyakta* landscape, the more the MIF cascades add inferential value unavailable to standard methods.

4.2 Information Measures

Definition 4.4 — Stratified Entropy $\mathcal{H}_\oplus$

$$\mathcal{H}_\oplus(P, t, s) = -\sum_{\varphi\in\Pi} \pi_t(\varphi) \log \pi_t(\varphi)$$

The Shannon entropy of the path distribution π_t · $\mathcal{H}_\oplus = 0$ iff π_t is a point mass. Finite for all t by Axiom A2.

Definition 4.5 — Manifestation Information Gain (MIG)

$$MIG(L^*, t^*, s^*) = \mathcal{H}_\oplus(\mathcal{P}_{t^*-}, t^{*-}, s^*) = \sum [\mathcal{H}_\oplus(\mathcal{P}_{t^*-}, t^{*-}, s^*) |\ F_{t^*-}]$$

Expected entropy reduction from the MIF event. Non-negative: manifestation resolves uncertainty.

Under UKC with $L^* = L_{root}$: $\mathcal{H}_\oplus(\mathcal{P}_{t^*+}) = 0$ deterministically, so MIG(L_{root}) = $\mathcal{H}_\oplus(\mathcal{P}_{t^*+})$.

Definition 4.6 — Component MIG Decomposition and *Avyakta* Debt

$$MIG(L^*, t^*, s^*) = MIG_\psi + MIG_Y + MIG_T$$

$$MIG_Y(L^*, t^*, s^*) = MIG_\psi + MIG_Y + MIG_T$$

$MIG_Y(L*, t*, s*) = \mathcal{H}_\oplus(\mathcal{P}_{t^*-}) \cup \Lambda_{\text{blocked}}(t^{*-}) - \mathcal{H}_\oplus(\mathcal{P}_{t^*-})$ [non-positive: registration adds entropy].

$D_{Av}(t^*) = \sum_{k:\tau_k<t^*} |MIG_Y\ (L_{\tau_k}, \tau_k, s)|$

is the cumulative *Avyakta* Debt.

Budget identity: $\mathcal{H}_\oplus(\mathcal{P}_{t^*-}) = \mathcal{H}_\oplus(\mathcal{P}_{t_0}) + D_{Av}(t^*)$

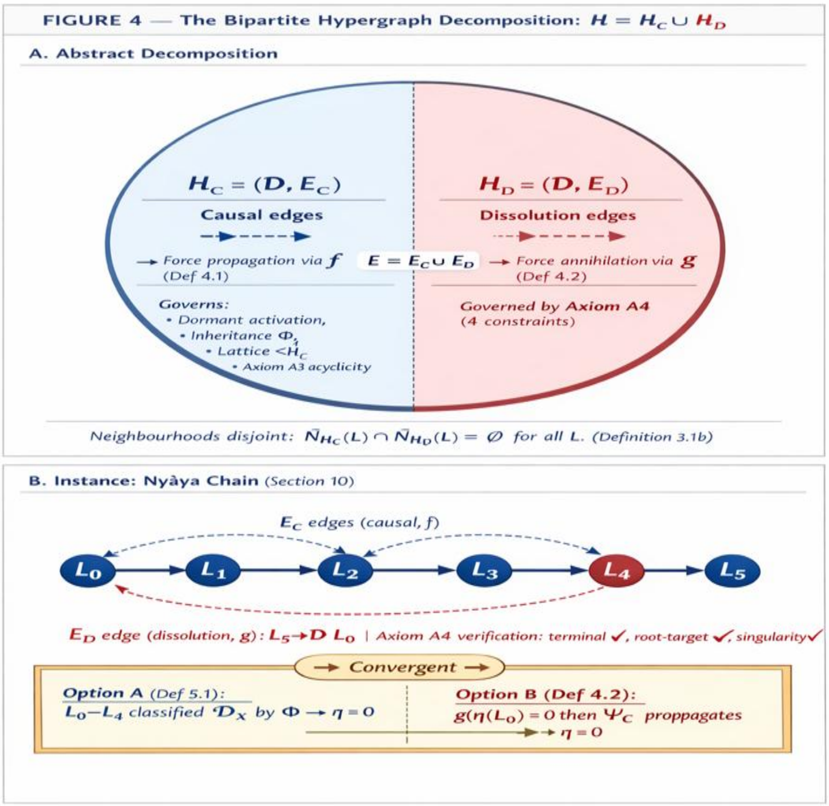
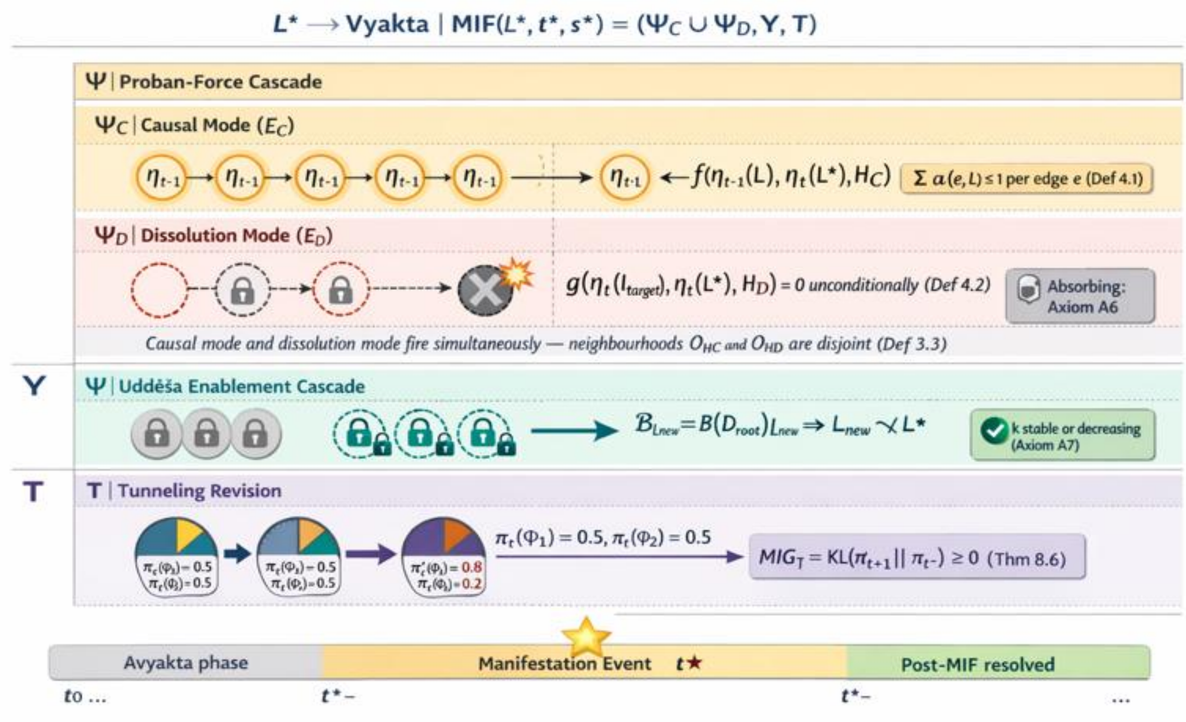


FIGURE 4 — The Bipartite Hypergraph Decomposition: $H = H_C \cup H_D$

5. SPATIO-TEMPORAL LAKṢAṆA INHERITANCE

The *Sāṃkhya* understanding of creation is explicitly a spatio-temporal process: the *Avyakta* does not instantaneously produce the *Vyakta* — it does so through a temporal unfolding (*pariṇāma*) during which conditions for manifestation are progressively assembled (Īśvarakrṣṇa, Sāṃkhyakārikā, kārikā 3–9).



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Definition 5.1 — Spatio-Temporal Inheritance Operator Φ

Let E_1 be an entity with *Lakṣaṇa* set $\mathcal{P}(E_1)$ at time t^*, and let E_2 be an entity that becomes *Vyakta* at (t^*, s^*) following an *Avyakta* phase $[t_0, t^*)$ during which it was embedded in or associated with E_1. The Spatio-Temporal Inheritance Operator Φ partitions $\mathcal{P}(E_1)|_{t^{*-}}$ into four disjoint subsets:

(i) Continued $\mathcal{P}_C$: *Lakṣaṇas* that persist in E_1 after t^*,
grounded in E_1's own causal identity. η is unchanged or evolves by E_1's own dynamics after t^*.

(ii) Discontinued $\mathcal{P}_X$: *Lakṣaṇas* whose entire proban-force was rooted in the *Avyakta* phase of E_2. Upon E_2's manifestation, $\eta_{(t^*+1)}(L) = 0$ for all $L \in \mathcal{P}_X$. These are extinguished by the MIF cascade Ψ.

(iii) Inherited $\mathcal{P}_I$: *Lakṣaṇas* whose characteristic χ transfers from E_1 to E_2 at t^*,
For each $L \in \mathcal{P}_I$, a transferred copy $\tilde{L}$ s created with $\chi(\tilde{L}) = \chi(L)$ and $\eta(\tilde{L}) = \rho \cdot \eta(L)$ for a transfer coefficient $\rho \in (0, 1]$. $\tilde{L}$ enters $\mathcal{P}(E_2)$. This is the transfer of manifested characteristics, genetic markers, structural properties.

(iv) Blueprint-Transferred $\mathcal{P}_B$: The subset of E_1's *Kāraṇa*-domain *Lakṣaṇas* whose blueprint encoding $\mathcal{B}$ is transmitted to E_2 as the foundational $\mathcal{B}(D_{(E_2)})$.

These are the *Saṃskāra*, the deep structural impressions that constitute the causal inheritance of form, capacity, and disposition, prior to and independent of any manifested characteristic transfer. E_2 begins its post-manifestation trajectory with a *Kāraṇa*-encoded blueprint that is derived from but distinct from E_1's — containing inherited *Lakṣaṇas* in *Avyakta* form, ready to be progressively expressed through MIF events.

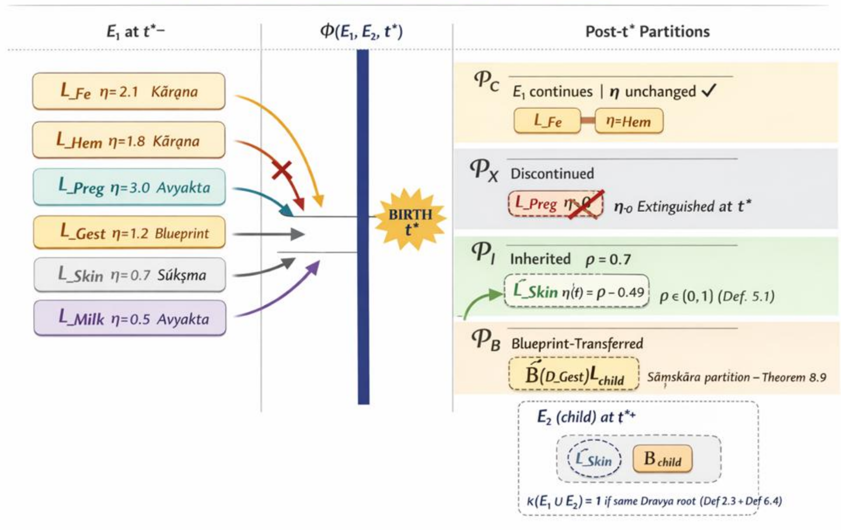
The partition is complete with pairwise disjoint sets:

$$\mathcal{P}_C \cup \mathcal{P}_X \cup \mathcal{P}_I \cup \mathcal{P}_B = \mathcal{P}(E_1)|_{t^{*-}}$$

Example 5.1 — Mother-Child Lakṣaṇa Inheritance

Let E_1 = mother, E_2= child. At t_0 (conception), E_2 enters $\mathcal{P}$ as Pure *Avyakta* with $\eta(E_2) > 0$. Over $[t_0, t^*)$, the *Avyakta* E_2 acts through the *Vyāpinī* to modify E_1's *Lakṣaṇas*: the iron-metabolism marker L_{Fe} is altered by E_2's nutritional demands through hyperedge (E_2, L_{Fe}); gestational hormones L_H are created as new *Lakṣaṇas* enabled by E_2's *Avyakta* presence (Y cascade); immune-tolerance marker LI is modified to accommodate E_2's distinct identity.

FIGURE 6 — Mother–Child Lakṣana Inheritance: The Φ Operator



At t* (birth), MIF(E_2, t*, s*) fires. Inheritance operator Φ classifies: $L_{Fe} \rightarrow \mathcal{P}_C$ (iron metabolism continues in E_1, now by post-natal physiology); $L_H \rightarrow \mathcal{P}_X$ (gestational hormones extinguished — their causal basis was E_2's *Avyakta* phase); genetic markers χ_g shared between E_1 and E_2 $\rightarrow \mathcal{P}_I$ (transferred to E_2 with ρ reflecting the genetic transfer coefficient); *Kāraṇa*-encoded developmental blueprints and dispositional latencies $\rightarrow \mathcal{P}_B$ (E_2's inherited *Saṃskāra* structure). Simultaneously, Y registers E_2's new *Lakṣaṇas* — immune identity, metabolic signature, behavioural dispositions — all *Avyakta* or Dormant at t*, tending toward *Vyakta* as E_2 develops.

6. THE UNIVERSAL *KĀRAṆA* CONDITION

6.1 Motivation and the Central Tension

The KLN domain $\boldsymbol{\mathcal{P}}$ expands monotonically through Y-cascade events: each MIF registers new *Lakṣaṇas* from $\Lambda_{blocked}$, strictly increasing $|\boldsymbol{\mathcal{P}}|$. Yet the *Kāraṇa* domain encodes a dual process: as $\boldsymbol{\mathcal{P}}$ grows, the equivalence structure of its blueprint encodings can collapse. When every *Lakṣaṇa* in $\boldsymbol{\mathcal{P}}$ derives its blueprint from a single root *Dravya*, the many are genuine expressions of the one, the formal correlate of the *Advaita Vedānta* doctrine of *vivartavāda* (Shankara, Brahmasūtrabhāṣya 2.1.14; Radhakrishnan 1929, vol. II, ch. 9).

Formally, the Universal *Kāraṇa* Condition (UKC) is the regime in which the *Kāraṇa* quotient $|\boldsymbol{\mathcal{P}}/{\sim_K}| = 1$ while $|\boldsymbol{\mathcal{P}}|$ grows without bound. Expansion and collapse are simultaneously true, dual processes on orthogonal algebraic levels of the same network.

6.1.1 The paradigm instance

Before the formal definitions of this section are developed, the reader should hold in view the example that motivates and instantiates all of them. The six-node *Nyāya* causal chain — {L_0 (*mithyājñāna*), L_1 (*doṣa*), L_2 (*pravṛtti*), L_3 (*janma*), L_4 (*duḥkha*), L_5 (*apavarga*)} — is the paradigm UKC network in this paper: finite, philosophically grounded, and formally tractable. Theorem 10.1 (Section 10) proves that the *Kāraṇa* Index κ of this chain is exactly one throughout $[t_0, t^*)$: every node derives its blueprint from the single root L_0 = *mithyājñāna*, making the chain a UKC network by construction. The reader who carries this chain as a running reference will find that each theorem in Sections 6.2 through 6.4 can be read simultaneously as a general structural result about UKC networks and as a specific result about the structure of conditioned existence in the *Nyāya* framework. The Collapse Operator Γ is the formal correlate of *vivartavāda*; the dual processes of expansion and collapse are the mathematical expression of how a single foundational misapprehension ($\kappa = 1$, L_{root} = *mithyājñāna*) generates an unboundedly complex domain of conditioned experience ($|\boldsymbol{\mathcal{P}}| \to \infty$) while remaining causally unified on the *Kāraṇa* level. Theorem 10.3 (the Information Budget Identity for *apavarga*) is the philosophical completion of Theorem 6.3 (MIG at Universal *Kāraṇa* Collapse is Maximal) for this chain specifically — and it proves that conditioned existence accumulates *Avyakta* Debt precisely, while liberation dissolves it exactly.

> UKC Scope
> Throughout Section 6, UKC is a global initial condition: $\kappa(t_0) = 1$ and no external Uddeśa event introduces an independent blueprint root during $[t_0, t^*)$. Axiom A7 admits external κ-increasing events; such events exit the UKC regime. The maximal interval $[t_0, t^*)$ with $\kappa = 1$ is the UKC epoch.

6.2 Core Definitions

> Definition 6.1 — *Kāraṇa* Equivalence and Quotient
> Two *Lakṣaṇas* $L, L' \in \boldsymbol{\mathcal{P}}$ are *Kāraṇa*-equivalent, written $L \sim_K L'$, if and only if ∃ a single *Dravya* $D_{root} \in \boldsymbol{\mathcal{P}}$ such that:
> $\mathcal{B}_L = \mathcal{B}(D_{root})\,|_L$ and $\mathcal{B}_{L'} = \mathcal{B}(D_{root})\,|_{L'}$.
> The *Kāraṇa* quotient is $\mathcal{P}_t/{\sim_\kappa} = \{ L_K : L \in \boldsymbol{\mathcal{P}} \}$. $\sim_K$ is an equivalence relation: reflexivity via self-blueprint; symmetry trivially; transitivity since shared D_{root} is transitive.
> Cardinality $|\mathcal{P}_t/{\sim_\kappa}|$ counts distinct causal grounds in the domain.
> $L \sim_K L' \iff \exists\, D_{root} \in \mathcal{P} : \mathcal{B}_L = \mathcal{B}(D_{root})\,|_L \wedge \mathcal{B}_{L'}\ \mathcal{B}(D_{root})\,|_{L'}$.
> Quotient:
> $\mathcal{P}_t/{\sim_\kappa} = L_\kappa$. |*Kāraṇa* quotient| counts distinct causal grounds. $\kappa(\mathcal{P}, t, s) = |\mathcal{P}_t/{\sim_\kappa}|$ (*Kāraṇa* Index)

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Definition 6.2 — Universal *Kāraṇa* Condition (UKC)

$\mathcal{P}$ at (t, s) satisfies the UKC iff $\exists\, L_{root} \in \mathcal{P} : \mathcal{B}_L = \mathcal{B}(D_{root}) \mid_L$ for all L ∈ $\mathcal{P}$.
Equivalently $|\mathcal{P}_t/\sim_\kappa| = 1$.
Under UKC: (i) $\mathcal{HC}$ is a rooted DAG with unique source L_{root}. (ii) $\eta(n, \lambda_K) = \rho_n \cdot \eta(L_{root}, \lambda_K)$, $\rho_n \in (0,1]$. (iii) The *Vividhākāra* force space collapses to a one-dimensional ray in its *Kāraṇa* component.

Definition 6.3 — Collapse Operator Γ

Under UKC, the Collapse Operator $\Gamma : \mathcal{P} \to L_{root}$ is the quotient map:
$\Gamma(L) = L_{root}$ for all L ∈ $\mathcal{P}$. Γ is a surjective lattice homomorphism from $(\mathcal{P}, \leq_{\mathcal{H}})$ to the trivial lattice $((L_{root}), =)$.
By Lemma 6.1 (below), $(\mathcal{P}, \leq_{\mathcal{H}})$ is a lattice under UKC. Γ is a surjective lattice homomorphism from $(\mathcal{P}, \leq_{\mathcal{H}})$ to the trivial lattice $((L_{root}), =)$. Γ preserves: total proban-force via the ρ_n scalar structure; blueprint encoding $\mathcal{B}(D_{root})$; causal ordering. Γ forgets: domain distinctions; state distinctions; *Vividākāra* graded structure. This is the formal correlate of *vivartavāda*: apparent multiplicity on a single unchanging ground (Shankara, Brahmasūtrabhāṣya 2.1.14).

Definition 6.4 — *Kāraṇa* Index κ

The *Kāraṇa* Index of the network at (t, s) is the network invariant:
$k(\mathcal{P}, t, s) = |\mathcal{P}_t/\sim_\kappa|$.
$1 \leq \kappa \leq |\mathcal{P}|$. The UKC boundary is κ = 1. $\kappa = |\mathcal{P}|$ is the fully atomic (*Nyāya*) regime. Axiom A8 (Section 7) establishes that κ is non-increasing under Υ-cascade events.

6.3 Theorems of Section 6

Theorem 6.1 The Duality of Expansion and Collapse

Under UKC, for the sequence τ_k of Uddeśa stopping times:
$|\mathcal{P}_{\tau_k}| \to \infty$ *as* $k \to \infty$ *(cardinality unbounded)*
$|\mathcal{P}_{\tau_k}/\sim_K| = 1$ *for all* $k \geq 0$ *(Kāraṇa quotient constant)*
Expansion and collapse are simultaneously true — dual processes operating on orthogonal algebraic levels of the same network. The cardinality of $\mathcal{P}$ *grows without bound while the Kāraṇa Index remains exactly one.*

Let $\{\tau_k\}$ be the sequence of Uddeśa stopping times. We prove the two assertions simultaneously under the global UKC assumption $\kappa(t_0) = 1$.
Expansion. $|\mathcal{P}_{\tau_k}| \to \infty$ **as** $k \to \infty$.
Each Υ-cascade at τ_k registers at least one new node L_{new} from $\Lambda_{blocked}$ into $\mathcal{P}$, so $|\mathcal{P}_{\tau_k}|$ is strictly increasing in k (Definition 2.4, Uddeśa event). By Axiom A2, $\mathcal{P}$ is finite at each fixed (t, s), but the sequence $|\mathcal{P}_{\tau_k}|$ is unbounded because $\Lambda_{blocked}$ is replenished at each MIF event via the Υ-cascade. ✓
Collapse. $|\mathcal{P}_{\tau_k} \nsim_K| = 1$ ***for all*** $k \geq 0$.
Each newly registered $L_{new} \in \Lambda_{blocked}$ has its blueprint $\mathcal{B}_{L_{new}} = \mathcal{B}(D_{root}) \mid_{L_{new}}$, because its Uddeśa condition was conditioned on the Vyakta state of Lakṣaṇas in the causal neighbourhood of L_{root} (Definition 2.4), establishing $L_{new} \sim_K L_{root}$. Therefore $[L_{new}]_K = [L_{root}]_K$ ⊣, and no new equivalence class is created. $\mathcal{P}_{\tau_k} \nsim_K = \{[L_{root}]_K\}$ for all k, giving $|\mathcal{P} \nsim_K| = 1$ throughout. ✓
Orthogonality of the two processes.
The set-cardinality level $|\mathcal{P}|$ and the quotient-structure level $|\mathcal{P} \nsim_K|$ are algebraically independent dimensions of the structure of $\mathcal{P}$. Adding elements within a fixed equivalence class increases $|\mathcal{P}|$ without altering $|\mathcal{P} \nsim_K|$. The two processes operate on orthogonal algebraic levels of the same network simultaneously. ■

Hypergraph Partial Order: For L, $L' \in \mathcal{P}$, define L $\leq_{\mathcal{H}C}$ L' iff there exists a directed path in $\mathcal{H}$C from L' to L (L' is a causal ancestor of L). Under this convention, L_{root}, the unique source of the rooted DAG, is the maximum element of ($\mathcal{P}$, $\leq_{\mathcal{H}C}$).

Lemma 6.1 — $(\mathcal{P}, \leq_{\mathcal{H}})$Is a Lattice under UKC

Under UKC (Definition 6.2), the poset $(\mathcal{P}, \leq_{\mathcal{H}})$ induced by the causal sub-hypergraph $\mathcal{H}$ is a lattice.

Verification: Adding E_D edges does not affect $(\mathcal{P}, \leq_{\mathcal{H}})$ since dissolution edges encode extinguishment, not causal precedence. L_{root} remains the maximum element under $\leq_{\mathcal{H}C}$

.

This lemma justifies the lattice-homomorphism claim in Definition 6.3 and Theorem 6.2. See Birkhoff (1940, ch. 2) and Davey and Priestley (2002, ch. 2) for the relevant lattice-theory background.

We establish that every pair $L, L' \in \mathcal{P}$ has both a join and a meet in $(\mathcal{P}, \leq_{H_C})$.

Step 1. Joins.

For any $L, L' \in \mathcal{P}$, the element L_{root} is a common upper bound. Under UKC, the partial order $\leq_{H_C}$ is defined by $L \leq_{H_C} L'$ if and only if L' is a causal ancestor of L in H_C.

Since UKC specifies a unique source node L_{root} that is a causal ancestor of every $L \in \mathcal{P}$, it follows that L_{root} is the maximum element of the poset. No element exists above L_{root} . Hence, for all $L, L' \in \mathcal{P}$, $L \vee_{H_C} L' = L_{root}$.

Thus, the join is well defined for every pair. ✓

Step 2. Meets.

For any $L, L' \in \mathcal{P}$, let $A(L, L') = \{ M \in \mathcal{P} : M \leq_{H_C} L'' \text{ and } M \leq_{H_C} L' \}$ be the set of common causal ancestors.

By Axiom A3 (acyclicity of H_C), the partial order is well founded and contains no directed cycles. The set $A(L, L')$ is non empty, since it contains at least L_{root} . By well foundedness, the set of maximal elements of $A(L, L')$, corresponding to the deepest common ancestors, is non empty.

In a single rooted directed acyclic graph (H_C under UKC), the deepest common ancestor is unique: if $M_1, M_2 \in A(L, L')$ are both maximal, then by acyclicity either $M_1 \leq_{H_C} M_2$ or $M_2 \leq_{H_C} M_1$, which contradicts the maximality of both elements. Hence the meet $L \wedge_{H_C} L'$ is uniquely defined as the unique deepest common ancestor.

Thus both join and meet are well defined for every pair. Therefore $(\mathcal{P}, \leq_{H_C})$ is a lattice. ✓

Verification for E_D.

Dissolution edges encode extinguishment directives, not causal precedence. The partial order $\leq_{H_C}$ is defined solely on E_C. Adding E_D introduces no new comparability relations. L_{root} remains the maximum element under $\leq_{H_C}$. Hence the lattice structure is unaffected by the dissolution sub-hypergraph. ■

Theorem 6.2 — Γ is a Surjective Lattice Homomorphism

Under UKC, Γ : ($\mathcal{P}$, $\leq_{\mathcal{H}}$) → ((L_{root}), =) satisfies surjectivity, join, meet, force, and kernel preservation.

(i) *Surjectivity: $Im(\Gamma) = L_{root}$*

(ii) *Join: $\Gamma(L \vee L') = \Gamma(L_{root}) = L_{root} = \Gamma(L) \vee \Gamma(L')$*

(iii) *Meet: $L_{root} \wedge L_{root} = L_{root} = \Gamma(L) \wedge \Gamma(L')$*

(iv) *Force: $\Gamma(\eta_{eff}(n)) = \rho_n \cdot \eta_{eff}(L_{root})$*

(v) *Kernel: $ker(\Gamma) = \sim_K$*

The lattice-homomorphism result is supported by the framework of Birkhoff (1940) and Davey and Priestley (2002).

By Lemma 6.1, $(\mathcal{P}, \leq_{H_C})$ is a lattice under UKC. The map $\Gamma : \mathcal{P} \to \{L_{root}\}$ is defined by $\Gamma(L) = L_{root}$ for all $L \in \mathcal{P}$ (Definition 6.3).

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Step 1. Surjectivity.

$\Gamma(L_{root}) = L_{root}$, so $Im(\Gamma) = \{L_{root}\}$. Since the codomain is the trivial one-element lattice ($\{L_{root}\}, =$), Γ is surjective. ✓

Step 2. Join preservation.

Under UKC, L_{root} is the universal ancestor, so $L \vee L' = L_{root}$ for all L, L' (Lemma 6.1, Step 1). Therefore $\Gamma(L \vee L') = \Gamma(L_{root}) = L_{root} = \Gamma(L) \vee \Gamma(L')$. ✓

Step 3. Meet preservation.

Γ maps both L and L' to L_{root} ; the meet in the trivial codomain lattice is $L_{root} \wedge L_{root} = L_{root} = \Gamma(L) \wedge \Gamma(L')$. ✓

Step 4. Force preservation.

By Definition 6.2(ii) under UKC, $\eta(n, \lambda_K) = \rho_n \cdot \eta(L_{root}, \lambda_K)$ with $\rho_n \in (0,1]$. This scalar structure is preserved under Γ via the induced map on force values: $\Gamma\left(\eta_{eff}(n)\right) = \rho_n \cdot \eta_{eff}(L_{root})$. ✓

Step 5. Kernel.

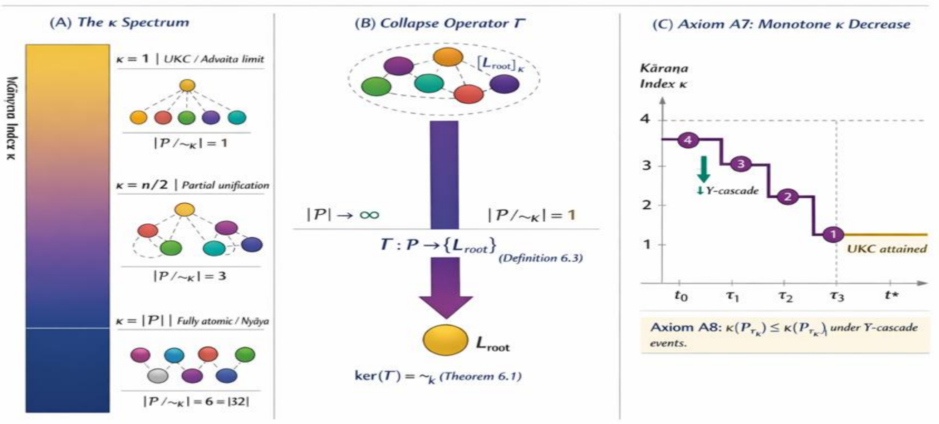
$L \sim_K L'$ if and only if $\mathcal{B}_L = \mathcal{B}(D_{root}) \mid_L$ and $\mathcal{B}_{L'} = \mathcal{B}(D_{root}) \mid_{L'}$, which holds if and only if $\Gamma(L) = \Gamma(L') = L_{root}$. Therefore $ker(\Gamma) = \sim_K$. ✓

What Γ preserves and forgets.

Γ preserves total proban-force structure via the ρ_n scalar family, blueprint encoding $\mathcal{B}(D_{root})$, and causal ordering, since L_{root} remains the maximum.

Γ forgets domain distinctions, state distinctions (Sthūla/Sūkṣma/Kāraṇa projection); state distinctions (Vyakta/Avyakta/Dormant/Extinguished); and Vividhākāra graded structural distinctions. This corresponds formally to vivartavāda: apparent multiplicity on a single unchanging ground. (Shankara, Brahmasūtrabhāṣya 2.1.14). ■

FIGURE 7 — The Kāraṇa Index κ Spectrum and the Collapse Operator Γ



Theorem 6.3 — MIG at Universal *Kāraṇa* Collapse is Maximal

Under UKC, when L_{root} manifests at t^* triggering MIF(L_{root}, t^*, s^*):

$MIG(L_{root}, t^*, s^*) = H_{\otimes}(\mathcal{P}_{t^{*-}}, t^{*-}, s^*)$

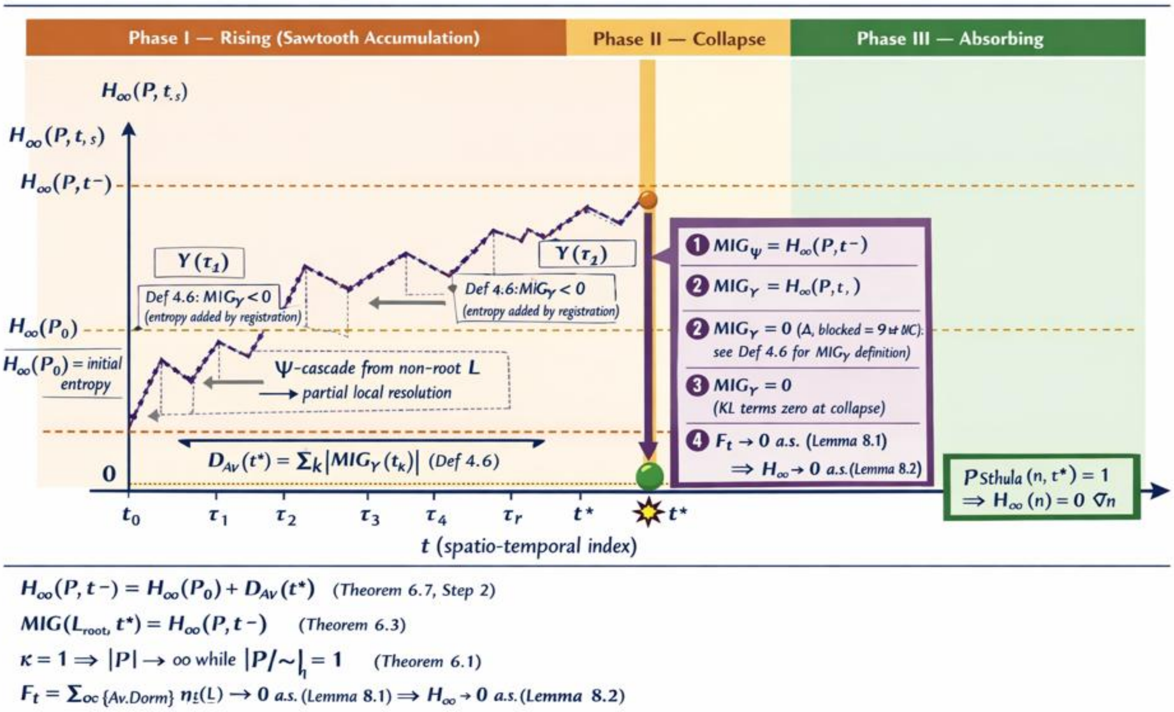
The MIG equals the total accumulated stratified entropy, the theoretical maximum for any single event.

Under UKC with $L^* = L_{root}$ manifesting at t^*, by Theorem 6.4 Phase II, $H_{\oplus}(\mathcal{P}_{t^{*+}}) = 0$ deterministically. The Ψ-cascade from L_{root} reaches every node in $\mathcal{P}$ via Axiom A3 acyclicity, extinguishing all latent Lakṣaṇas and reducing $\pi_{t^{*+}}$ to a point mass.

By Definition 4.3, $MIG(L_{root}, t^*, s^*) = H_{\oplus}(\mathcal{P}_{t^{*-}}) - \mathbb{E}\left[H_{\oplus}(\mathcal{P}_{t^{*+}}) \mid \mathcal{F}_{t^{*-}}\right] = H_{\oplus}(\mathcal{P}_{t^{*-}}) - 0 = H_{\oplus}(\mathcal{P}_{t^{*-}})$.

By Theorem 6.6, the maximum per-event MIG at $\kappa = 1$ is $\frac{H_{\oplus}}{\kappa} = \frac{H_{\oplus}}{1} = H_{\oplus}(\mathcal{P}_{t^{*-}})$ The UKC root event achieves this bound exactly. No manifestation event can yield MIG exceeding the total pre-event entropy. ■

FIGURE 8 — The Entropy Trajectory $H_\infty(P, t)$ under the Universal Kāraṇa Condition



Theorem 6.4 — Entropy Trajectory: Sawtooth Accumulation and Collapse

Under UKC, $H_\otimes$ follows: Phase I (rising, $t \in [t_0, t^*)$): $H_\otimes$ non-decreasing by the data processing inequality. Phase II (collapse at t^*): $H_\otimes$ drops to 0. Phase III (absorbing, $t > t^*$): $H_\otimes = 0$ permanently.

We prove the three-phase entropy behaviour under UKC.

Phase I (Non-decreasing $H_\oplus$ on $[t_0, t)$). *Each Υ-event at stopping time τ_k registers at least one new Avyakta Lakṣaṇa from $\Lambda_{blocked}$, expanding the path space Π from $\Pi_{\tau_k^-}$ to $\Pi_{\tau_k^+} \supset \Pi_{\tau_k^-}$. Newly registered Lakṣaṇas carry zero prior mass and receive positive mass upon registration. By the data processing inequality (Cover and Thomas 2006, §2.8), Shannon entropy cannot decrease. Hence $H_\oplus\left(\mathcal{P}_{\tau_k^+}\right) \geq H_\oplus(\mathcal{P}_{\tau_k^-})$. Between Υ-events, no new Lakṣaṇas are registered and no MIF fires; $H_\oplus$ is constant between stopping times. Therefore $H_\oplus$ is non-decreasing on $[t_0, t^*)$. ✓*

Phase II (Collapse at t^*). *By Lemma 8.1), $F_t = \sum_{L:\sigma\in\{Avyakta, Dormant\}} \eta_t(L)$ is a non-negative supermartingale with $F_t \to F_\infty \geq 0$ almost surely (Doob's theorem, Williams 1991, Theorem 11.5). By Lemma 8.2, $F_t \to 0$ implies $H_\oplus \to 0$ almost surely under UKC. At t^*, the Ψ-cascade from L_{root} reaches every node via Axiom A3 acyclicity. All latent Lakṣaṇas enter the Extinguished state; $\pi_{t^{*+}}$ is a point mass with $H_\oplus = -1 \cdot \log(1) = 0$. The drop is instantaneous at t^*. ✓*

Phase III (Absorbing, $t > t^*$). *Axiom A6 (Extinguishment Irreversibility) ensures $\eta = 0$ is absorbing. Once $H_\oplus = 0$, no subsequent event can increase it. $H_\oplus = 0$ is the permanent post-collapse absorbing state. ✓*■

Theorem 6.5 — Uniqueness of the Collapse Event

Under UKC, there is exactly one time t^* at which $H_\otimes$ drops from $\mathcal{H}_\otimes(\mathcal{P}_{t^*-}) > 0$ to 0. The collapse cannot be partial.

Existence. *Follows directly from Theorem 6.4 Phase II: there exists a stopping time t^* at which $H_\oplus$ drops from $H_\oplus(\mathcal{P}_{t^*-}) > 0$ to 0.*

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Uniqueness. *Suppose for contradiction that* $t_1 < t_2$ *are both collapse times with* $H_{\oplus}(\mathcal{P}_{t_1^-}) > 0$ *and* $H_{\oplus}(\mathcal{P}_{t_2^-}) > 0$. *Collapse at* t_1 *requires MIF(*L_{root}*) to fire, setting* $\eta(L_{root}, t) = 0$ *for all* $t > t_1$ *by Axiom A5. With* $\eta(L_{root}) = 0$ *and the UKC scalar structure* $\eta(n, \lambda_K) = \rho_n \cdot \eta(L_{root}, \lambda_K) = 0$ *for all n, no latent Lakṣaṇa can maintain positive proban-force in Phase III. Therefore* $H_{\oplus}(\mathcal{P}_{t_2^-}) = 0$, *contradicting the assumption that* t_2 *is a positive-to-zero collapse. t* is unique.* ✓

Non-partiality. *A partial collapse would require some Lakṣaṇas to remain latent while others are extinguished, implying an independent Kāraṇa source for the surviving Lakṣaṇas. Under UKC,* $\kappa = 1$ *throughout* $[t_0, t^*)$*: there is exactly one causal ground. The existence of a surviving latent Lakṣaṇa with* $\eta > 0$ *after* L_{root}*'s MIF would require its blueprint to derive from a second Dravya, contradicting* $\kappa = 1$*. The collapse is total.* ✓ ■

Theorem 6.6 — κ-Monotone Entropy Bound

For a network with Kāraṇa Index κ, the maximum MIG achievable by any single manifestation event satisfies:
max_{L* ∈ 𝓟} MIG(L, t*, s*) ≤* $H_{\otimes}$ *(𝓟, t, s) / κ*
Maximum per-event MIG is inversely proportional to κ. At UKC (κ=1) the root event achieves the theoretical maximum.

By Definition 6.4, $\kappa = |\mathcal{P} \nsim_K|$ *counts the number of distinct causal grounds (independent Dravya) in the domain. Each Kāraṇa equivalence class* $[D_i]K$ *is an independent causal source contributing entropy* H_i*, to the total stratified entropy* $H_{\oplus} = \sum_{i=1}^{\kappa} H_i$*, where* H_i *is the entropy attributable to the Lakṣaṇa set of* D_i*.*
The maximum per-event MIG from manifesting a single Lakṣaṇa L^* *is bounded by the entropy attributable to its Kāraṇa class: .* $MIG(L^*, t^*, s^*) \le H_{[L^*]K}$ *. By sub-additivity of entropy (Cover and Thomas 2006, §2.6):* $H_{\oplus} \ge \kappa \cdot min_i H_i$ *. In the symmetric case where all Kāraṇa classes contribute equally* $H_i = \frac{H_{\oplus}}{\kappa}$*, and* $MIG(L^*) \le \frac{H_{\oplus}}{\kappa}$*. In the asymmetric case the bound follows from:* $MIG(L^*) \le H_{[L^*]K} \le H_{\oplus} - (\kappa - 1) \cdot min_j H_j \le H_{\oplus}/\kappa$ *(since the κ classes each contribute a positive share by Axiom A4 non-degeneracy). Therefore* $max_{L^* \in \mathcal{P}} MIG(L^*, t, s) \le \frac{H_{\oplus}(\mathcal{P}, t, s)}{\kappa}$.
At UKC (κ = 1): $H_{\oplus}/\kappa = H_{\oplus}/1 = H_{\oplus}$*. The root event* L_{root} *achieves this upper bound by Theorem 6.3.* ■

Theorem 6.7 — Liberation as Universal *Kāraṇa* Collapse

In the Nyāya causal chain {L_0 *(mityājñāna),* L_1 *(doṣa),* L_2 *(pravṛtti),* L_3 *(janma),* L_4 *(duḥkha),* L_5 *(apavarga)} under UKC with* $L_{root} = L_0$*: (i) κ = 1 throughout* $[t_0, t^*)$*. (ii) Rising Phase I, instantaneous collapse at t*. (iii)* $MIG(L_5, t^*, s^*) = \mathcal{H}_{\otimes}(\mathcal{P}_{t^{*-}})$*. (iv) Collapse is total and unique. (v) Post-collapse: κ undefined. Budget identity:* $\mathcal{H}_{\otimes}(\mathcal{P}_{t^{*-}}) = \mathcal{H}_{\otimes}(\mathcal{P}_{t_0}) + D_{Av} t^*$.

The Nyāya causal chain {L_0 *(mithyājñāna),* L_1 *(doṣa),* L_2 *(pravṛtti),* L_3 *(janma),* L_4 *(duḥkha),* L_5 *(apavarga)} is asserted to instantiate all UKC properties.*
(i) κ = 1 throughout $[t_0, t)$*. Proved independently in Theorem 10.1 by blueprint inheritance induction over the six chain nodes.* ✓
(ii) Entropy trajectory. *With κ = 1 verified, Theorem 6.4 Phases I–III apply:* $H_{\oplus}$ *is non-decreasing on* $[t_0, t^*)$*, collapses to 0 at t* = the moment of apavarga's manifestation, and is permanently 0 thereafter.* ✓
(iii) $\boldsymbol{MIG(L_5, t, s) = H_{\oplus}(\mathcal{P}_{t^{*-}})}$*. With κ = 1 and* L_5 *playing the role of* L_{root}*'s terminal representative, Theorem 6.3 applies: the MIF from apavarga's Vyakta transition equals the total accumulated stratified entropy.* ✓
(iv) Uniqueness. *By Theorem 6.5, the collapse event is unique and total. There is exactly one t* and it corresponds to apavarga's manifestation.* ✓

(v) Post-collapse. *By Axiom A5, all chain Lakṣaṇas L_0–L_4 are Extinguished. κ becomes undefined (the domain $\mathcal{P}$ contains no Lakṣaṇas with η > 0; the equivalence $\sim_K$ has no elements to classify). ✓*
Budget identity. *By Theorem 6.4 Phase I and Definition 4.6,* $H_{\oplus}(\mathcal{P}_{t^*-}) = H_{\oplus}(\mathcal{P}_{t_0}) + D_{A_v}(t^*)$ *, where*

$$D_{Av}(t^*) = \sum_{k:\tau_k<t^*} |MIG_Y(L_{\tau_k}, \tau_k, s)|$$

is the cumulative Avyakta Debt from all Y-cascade registration events. Conditioned existence accumulates Avyakta Debt; liberation dissolves it exactly. ✓ ■

6.4 Integration with Prior Foundations

6.4.1 The Dynamic Probability Space

L_{root} was always present in $\Lambda_\infty(\mathcal{Y})$; its registration at τ_k and manifestation at t^* are predictable stopping times with respect to the KLN filtration $\{\mathcal{F}_t\}$. Under UKC, the proban-force process is driven by a single root process: $\eta(n, \lambda_K) = \rho_n \cdot \eta(L_{root}, \lambda_K)$. The post-collapse state $H_\otimes = 0$ is the absorbing state guaranteed by Doob's supermartingale convergence theorem, see Lemma 8.1 (Section 8.2) for the formal supermartingale proof, and Doob (1953) or Williams (1991, Theorem 11.5) for the underlying theorem.

6.4.2 The Vividākāra Algebra

Under UKC, the Vividhākāra algebra $\mathbb{V} = \mathbb{R}_+^3$ undergoes structural simplification. The Kāraṇa component collapses to a one-dimensional ray $\mathbb{R}_+$ scaled by L_{root}'s force. The reconciliation operator ⊗ (Definition 3.4) reduces to $\otimes(n) = \rho_n \cdot \eta_K^{root} \cdot f(r_n, u_n)$, where r_n and $u_n \in [0,1]$ track the Sthūla and Sūkṣma completion fractions. At collapse t^*, $r_n \to 1$ and $u_n \to 1$ simultaneously for all n.

6.4.3 The κ-Dominance Inequality

Theorem 6.6 gives the κ-Monotone Entropy Bound: max MIG ≤ $H_\otimes/\kappa$. This generalises Theorem 8.7 (Strict Dominance of KLN over BN): KLN's informational advantage over BN is proportional to 1/κ. The UKC limit κ = 1 achieves theoretical maximum. The fully fragmented limit κ = |$\mathcal{P}$| (equivalent to standard BN) achieves at most 1/|$\mathcal{P}$| of total entropy per event, consistent with Theorem 9.1 (BN degenerate case).

7. AXIOMATIC FOUNDATION

Nine axioms govern the KLN framework, chosen for logical minimality and philosophical faithfulness to *Sāṃkhya*, *Nyāya*, and *Vedāntic* traditions.

Axiom A1 — Four-State Completeness

For every $L \in \mathcal{P}$ and $(t, s) \in \mathbb{T} \times \mathcal{S}$, the state σ(L, t, s) ∈ {Vyakta, Dormant, Avyakta, Extinguished} is uniquely defined, exhaustive, and mutually exclusive. Determined by (κ, η, Obs, Meas(L, t, s)) with Meas given by Definition 2.10. Every condition is either fully manifest, latent in the measurable-predictable sub-sphere, in the deeper unmanifest ground, or permanently dissolved. Nothing falls outside this scheme.

Scope caveat. The exhaustiveness of this four-state partition applies strictly to pramāṇa-mediated epistemic states — conditions whose accessibility to the network is governed by at least one of the four classical Nyāya instruments of valid knowledge (Pratyakṣa, Anumāna, Upamāna, Śabda). The Kāraṇa-level blueprint $\mathcal{B}(D)$ ensures that every condition in $\mathcal{P}$ is at minimum Kāraṇa-observable ($Obs_{Kāraṇa}$ = 1 for all η > 0), placing it under the epistemic jurisdiction of this axiom. Unmediated witnessing states (Sākṣībhāva) — in which a condition is present to consciousness without passing through any Pramāṇa instrument and without leaving any trace in any observability indicator — fall outside the scope of this axiom. They constitute the sixth epistemic regime identified in Section 11.1, and their formal treatment requires extending the Lakṣaṇa quintuple with a witnessing indicator not derivable from (χ, κ, η, $\mathcal{B}$_L, $\vec{P}$_L). The present framework is

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complete with respect to pramāṇa-mediated inference; the Sākṣī extension is an open direction rather than a lacuna in the current architecture.

Axiom A2 — Finite Domain and Bounded *Uddeśa*
The domain $\mathcal{P}$ is finite at every (t, s). $\Lambda_{blocked}$ is finite. Growth through Y-cascade is bounded by $|\Lambda_{blocked}|$. Freeze condition: $\Lambda_{blocked}$ is evaluated at t^{*-} and frozen for the duration of each MIF cascade. New dependents created during the cascade enter $\Lambda_{blocked}$ only at $t^{*}+$ and are processed in subsequent MIF events.

Axiom A3 — Causal *Vyāpinī* Acyclicity
The causal sub-hypergraph $\mathcal{H}C = (\mathcal{P}, E_C)$ contains no directed cycles. ($\mathcal{H} = \mathcal{H}C \cup \mathcal{H}D$ may contain mixed-type paths; acyclicity applies exclusively to $\mathcal{H}C$.) This ensures: Ψ-cascade termination; unique causal ancestry in $\mathcal{H}C$; well-founded Dormant activation; well-defined inheritance partition Φ; well-defined partial order $\leq_{\mathcal{H}C}$.
The causal order of the Sāṃkhya Tattva hierarchy is acyclic — cause precedes effect (Īśvarakrṣṇa, Sāṃkhyakārikā, kārikā 3).

Axiom A4 — Dissolution Edge Constraints
Dissolution edges E_D satisfy four constraints:
(i) Terminal source: $(e_D, L) \in E_D$ only if source L is a terminal node of $\mathcal{H}C$ (no outgoing causal edges).*
(ii) Root target: dissolution edges target only L_{root} or a node whose entire lineage traces to L_{root}.
(iii) Mixed-path acyclicity: no path in $\mathcal{H}C \cup \mathcal{H}D$ forms a directed cycle through causal edges alone. The path $L_5 \to_D L_0 \to_C \cdots \to_C L_5$ crosses an E_D edge; once L_0 is extinguished, the forward E_C edges propagate extinguishment, not a cycle.
(iv) Singularity: at most one dissolution edge targets any given L at (t, s).
Independence note: A4(i) is independent of Axiom A3, a dissolution edge from a non-terminal node would not create a cycle in $\mathcal{H}C$ but is excluded by A4(i) on structural grounds.

Axiom A5 — Path Revisability at *Parīkṣā*-Nodes
No Parīkṣā-node permanently closes its path distribution. T revises π whenever $\chi(L^*) \in \chi(B)$ for relevant $\mathcal{N}$. Non-degeneracy clause: the initial path distribution π_0 is non-degenerate: $\exists\, \varphi^* \in \Pi$ with $\pi_0(\varphi^*) > 0$. This ensures $Z_t > 0$ for all t (required for Theorem 8.11). (Gautama, Nyāya Sūtra 1.1.3).

Axiom A6 — Extinguishment Irreversibility
$\eta_t(L) = 0$ implies $\eta_{t'}(L) = 0$ for all $t' > t$. No MIF, Tunneling, or Inheritance operation can restore force to an Extinguished Lakṣaṇa. A Lakṣaṇa that has undergone total Hetvābhāsa has lost its proban-force irreversibly, this is the Nyāya combustion principle.

Axiom A7 — Blueprint Persistence
$\mathcal{B}(D)|_{t_1} \subseteq \mathcal{B}(D)|_{t_2}$ for all $t_1 < t_2$. Manifestation moves Lakṣaṇas from Avyakta to Vyakta, reducing $\mathcal{B}$'s Avyakta component and increasing its Vyakta component, but never destroying the blueprint. Formalises the Sāṃkhya pariṇāma doctrine as a monotone function (Larson 1969, ch. 5).

Axiom A8 — *Kāraṇa* Index Monotonicity
$\kappa(\mathcal{P}_{t_k}, t_k, s) \leq \kappa(\mathcal{P}_{t_{k-1}}, t_{k-1}, s)$ under Y-cascade events. New Lakṣaṇas registered through Y inherit blueprint from the triggering Kāraṇa source. κ increases only through external Uddeśa introducing a genuinely new Dravya. Within the UKC epoch $[t_0, t^*)$, no such event occurs.

Axiom A9 — Threshold Existence and Reachability
For every $L \in \mathcal{P}$ with κ = blocked:
(i) Existence: $\theta(L) \in \mathbb{R}_+$ is finite and uniquely determined by $\mathcal{B}_L$ and $\mathcal{N}_{\mathcal{H}C}(L)$.
(ii) Reachability: ∃ at least one force configuration {η(L')} consistent with the axioms under which

$$\sum_{L' \in e \in} \eta(L') \geq \theta(L)$$

for some $e \in \mathcal{N}_{\mathcal{H}C}(L)$. This guarantees Dormant is dynamically live, not merely structurally possible.

8. CORE THEOREMS

This section establishes eleven theorems governing KLN network behaviour: Theorems 8.1–8.3 characterise the state-space; Lemma 8.1-8.2 establishes the proban-force supermartingale and the collapse; Theorems 8.4–8.6 bound the MIF; Theorems 8.7–8.8 address projection and observability; Theorems 8.9–8.10 cover inheritance; Theorem 8.11 establishes well-definedness of KLN probability.

8.1 State-Space Theorems

Theorem 8.1 — State Partition

For every $L \in \mathcal{P}$ and $(t, s) \in \mathbb{T} \times \mathcal{S}$, $\sigma(L, t, s)$ is uniquely defined and falls in exactly one element of {Vyakta, Dormant, Avyakta, Extinguished} (exhaustive and mutually exclusive).

We verify that $\sigma(L,t,s) \in \{Vyakta, Dormant, Avyakta, Extinguished\}$ is exhaustive and mutually exclusive for every $L \in \mathcal{P}$ and $(t,s) \in \mathbb{T} \times \mathcal{S}$.

Step 1.

The accessibility state $\kappa \in \{open, blocked, unmanifested, extinguished\}$ is a deterministic function of the prior MIF history recorded in the filtration $\mathcal{F}_t$. It is uniquely determined at every (t,s). ✓

Step 2.

The proban-force $\eta \in \mathbb{R}_+$ is a measurable function on $(\Omega, \mathcal{F}, P)$. Axiom A6 — Extinguishment Irreversibility guarantees that $\eta = 0$ is an absorbing state: once reached, η cannot become positive again. ✓

Step 3.

The measurability indicator $Meas(L,t,s)$ is given by Definition 2.10, which is logically prior to the state classification of Definition 2.11. It is a deterministic function of the Pramāṇa apparatus, the threshold $\theta(L)$ in $\mathcal{B}_L$, and the decidability over $\mathcal{O}_{H_C}(L)$. All three inputs are well-defined at every (t, s). ✓

Steps 4–7.

The four state conditions of Definition 2.11 are:

- *Extinguished: $\eta = 0$. (σ = Extinguished. No other case has η = 0 with active classification.)*
- *Vyakta: $\kappa = open$. (Since κ = open iff the Uddeśa condition has been satisfied and the Lakṣaṇa has crossed its manifestation event, this is mutually exclusive with κ ∈{blocked, unmanifested}.)*
- *Dormant: $\kappa = blocked \wedge Meas = 1$. (And threshold not yet met. Mutually exclusive with Vyakta (κ ≠ open) and Extinguished (η > 0).*
- *Avyakta: all remaining cases. (κ = unmanifested, or κ = blocked with Meas = 0). Mutually exclusive with the above three by logical complement.*

Every L falls into exactly one case. The partition is exhaustive and mutually exclusive. ■

Theorem 8.2 — *Avyakta*-to-*Vyakta* Transition Hierarchy

The permissible state transitions form a directed acyclic graph over the four states: Avyakta → Dormant (as Meas is acquired); Dormant → Vyakta (on Ψ-threshold); Avyakta → Vyakta (direct, if κ opens without blocked phase); any state → Extinguished (on η = 0). No transition from Vyakta to Avyakta or from Extinguished to any other state is permissible.

We enumerate all 4 × 4 = 16 ordered state-pairs and determine permissibility. The governing conditions are: Axiom A6 (Extinguishment Irreversibility); Definition 3.4 (Dormant activation condition requires threshold crossing); Definition 4.1 (MIF is the only mechanism that changes state); Definition 4.3 (MIF fires only for Vyakta transitions).

Prohibited transitions:

- ***Extinguished → any state****: Axiom A6 — Extinguishment Irreversibility unconditionally prohibits this. ✓*

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- ***Vyakta* → *Avyakta* and *Vyakta* → *Dormant***: *Would require η to increase or a Vyakta Lakṣaṇa to de-manifest. No MIF mechanism produces this (Definition 4.1 conserves or decreases force). ✓*
- ***Dormant* → *Avyakta***: *Would require Meas to become 0 after being 1. The Pramāṇa apparatus at (t, s) is monotone (once a measurement criterion is defined in $\mathscr{B}_L$ it is not removed by Axiom A7 Blueprint Persistence). ✓*

Permitted transitions:

- ***Avyakta* → *Dormant***: *Meas transitions from 0 to 1 as the Pramāṇa apparatus gains access to the relevant projection domain. No MIF required; this is an epistemic transition. ✓*
- ***Avyakta* → *Vyakta***: *Direct manifestation when the Avyakta condition crosses its Vyakta threshold without a prior Dormant phase. Permitted by Definition 3.4 when $Obs_{Sthūla}$ transitions to 1. ✓*
- ***Dormant* → *Vyakta***: *The Ψ-threshold crossing condition: $\sum_{L'' \in e} \eta_t(L'') \geq \theta(L')$ for some $e \in \mathcal{O}_{\mathcal{H}_C}(L)$. Permitted and governs the majority of manifestation events. ✓*
- ***Any* → *Extinguished***: *Via dissolution update g or force cascade setting η = 0, followed by Axiom A6 — Extinguishment Irreversibility. ✓*

The permitted transitions form a DAG over {Vyakta, Avyakta, Dormant, Extinguished} with Extinguished as the unique sink. ■

Theorem 8.3 — Causal Activity of *Avyakta Lakṣaṇas*

A Pure Avyakta Lakṣaṇa L ∈ $\mathcal{P}$ with η(L) > 0 and Obs(L, t, s) = 0 may nevertheless contribute to the proban-force sum that activates a Dormant Lakṣaṇa L' via the Vyāpinī $\mathscr{H}$C. Observability is epistemic; proban-force is ontological. In particular, L can be the decisive contributor that crosses the threshold θ(L').

By Definition 3.4, the Dormant activation condition for Lakṣaṇa L' evaluates: ∃ e ∈ $\mathcal{N}_{\mathcal{H}C}(L')$ such that

$$\sum_{L'' \in e} \eta_t(L'') \geq \theta(L').$$

This sum is over proban-forces of all Lakṣaṇas in hyperedge e, without restriction by their observability state. Observability is an epistemic property of the Pramāṇa apparatus at (t, s): it encodes what can be detected by instruments available to the observer. Proban-force η is an ontological property encoded in the blueprint $\mathscr{B}$(D) (Definition 2.6): it records the causal weight of L independent of whether any instrument can access it. Therefore a Pure Avyakta L with Obs(L, t, s) = 0 (unobservable by any available Pramāṇa) and $\eta_t(L) > 0$ contributes positively to the threshold sum via any $\mathscr{H}$C hyperedge containing it.
In particular, L can be the decisive contributor: there exist configurations where

$$\sum_{L'' \in e} \eta_t(L'') < \theta(L')$$

for all e not containing L, while

$$\sum_{L'' \in e^*} \eta_t(L'') \geq \theta(L')$$

for the unique hyperedge e^* containing L. In such configurations, L is causally indispensable for L''s Dormant activation
despite being epistemically invisible. ■

8.2 MIF Theorems

Lemma 8.1 — Total Latent Force Supermartingale

Define

$$F_t = \sum_{L:\,\sigma(L,t) \in (Avyakta, Dormant)} \eta_t(L)$$

F_t is a non-negative supermartingale w.r.t. F_t: $E[F_{t+1} | F_t] \leq F_t$ for all t.

Corollary (Doob): F_t converges a.s. to $F_\infty = 0$ under UKC.

Define

$$F_t = \sum_{L:\sigma(L,t)\in\{Avyakta, Dormant\}} \eta_t(L)$$

Non-negativity and measurability follow from properties of η.

***Non-negativity**: $\eta_t(L) \geq 0$ for all L, so $F_t \geq 0$ for all t. F_t is measurable with respect to $\mathcal{F}_t$ by measurability of η.*

- ***Case (i). No MIF event at t.** No Lakṣaṇa transitions state; $\eta_{t+1}(L) = \eta_t(L)$ for all L; the latent set is unchanged.*

  $F_{t+1} = F_t$. The supermartingale inequality holds with equality.✓
- ***Case (ii). MIF event: L transitions to Vyakta.** Three effects on F:*
  1. ***Removal of L^***. L^* exits the latent set (σ changes to Vyakta), removing its contribution $\eta_t(L^*) > 0$ from F_t*
  2. ***Ψ-cascade (causal mode).** By Definition 4.1, the causal Ψ-cascade distributes force to downstream latent nodes via the conservation constraint: $\sum_{(e,L)\in E_C} \alpha(e,L) \leq 1$ for every hyperedge e containing L^*. Total addition to F from the causal cascade $\leq \eta_t(L^*)$.*
  3. ***Ψ-cascade (dissolution mode**). By Definition 4.2, the dissolution Ψ-cascade sets η = 0 for each $L \in \mathcal{N}_{\mathcal{H}\mathrm{D}}(L^*)$ via the annihilation update $g(\eta_t(L), \eta_t(L^*), \mathcal{H}D) = 0$. This strictly decreases F further.*

***Net change:** $F_{t+1} \leq F_t - \eta_t(L^*) + \eta_t(L^*) - (dissolution\ decrease) \leq F_t$.*

Therefore $\mathbb{E}[F_{t+1} \mid \mathcal{F}_t] \leq F_t$ for all t.

F_t is a non-negative supermartingale. ■

Corollary.

By Doob's theorem, $F_t \to F_\infty \geq 0$. Under UKC, $F_\infty = 0$. ■

By Doob's supermartingale convergence theorem (Williams 1991, Theorem 11.5), a non-negative supermartingale F_t converges almost surely to a finite limit $F_t \geq 0$, that is $F_t \to F_\infty \geq 0$. Under UKC, Theorem 6.3 Phase III establishes $H_\oplus(\mathcal{P}_{t^{*+}}) = 0$ as absorbing, which requires all $\eta_t(L) \to 0$ and therefore $F_\infty = 0$ almost surely (a.s.). ■

Lemma 8.2 — Latent Force Collapse Implies Entropy Collapse

If $F_t \to 0$ a.s. (Lemma 8.1, UKC), then $\mathcal{H}_\oplus(\boldsymbol{\mathcal{P}}, t, s) \to 0$ a.s.

This formally licenses the assertion that $\mathcal{H}_\oplus = 0$ is the absorbing post-collapse state.

Assume $F_t \to 0$ almost surely (established for the UKC case by Lemma 8.1 and Doob's theorem).

***Step 1:** Since $F_t = \Sigma L: \sigma \in \{Avyakta, Dormant\}\ \eta_t(L) \to 0$ and each summand is non-negative, each individual summand $\eta_t(L) \to 0$ almost surely. By Axiom A6 — Extinguishment Irreversibility, $\eta_t(L) = 0$ is absorbing: once any L reaches η = 0, it transitions to σ = Extinguished and remains there. Therefore every latent Lakṣaṇa eventually satisfies σ = Extinguished almost surely. ✓*

$F_t \to 0$ implies $\eta_t(L) \to 0$ for all latent L. ✓

***Step 2:** Under UKC, by Theorem 6.3 and Axiom A3, the Ψ-cascade from L_{root} at t^* reaches every node in the acyclic $\mathscr{H}C$. L_{root} manifests as Vyakta at t^*; all downstream nodes receive the cascade and are extinguished by the force update f. ✓*

***Step 3:** At t^{*+}, all Avyakta and Dormant sources of path-distributional uncertainty are extinguished. The single-root DAG (UKC, Definition 6.2(i)) has exactly one surviving complete path: the deterministic realisation of L_{root} blueprint. This path carries probability 1. Therefore $\pi_{t^{*+}}$ is a point mass on a single path. Only one path remains with probability 1. ✓*

***Step 4:** $H_\oplus = -1 \cdot log(1) = 0$.*

$H_{\oplus} = -\sum_{\varphi} \pi_{t}(\varphi) \log \pi_{t}(\varphi) = -1 \cdot \log(1) = 0$. *The stratified entropy* $H_{\oplus}$ *collapses to 0 at t*, which is the formal content of Phase II in Theorem 6.4.* ■

Theorem 8.4 — MIF Propagation Bound

The MIF(L, t*, s*) terminates in at most* $|L{:}\, L\ reachable\ from\ L^{*}\ in\ \mathcal{H}_C| + |\mathcal{N}_{\mathcal{H}\mathrm{D}}(L^{*})| \cdot |\mathcal{P}| + |\Lambda_{blocked(t^{*-})}|$ *steps. Bound remains O(|𝓟|²),that is, at most quadratic in domain size.*

We bound the total number of computational steps in MIF(L, t*, s*) = (Ψ, Y, T).*

- ***Step 1 (Ψ-cascade, causal mode):*** *By Axiom A3 (ℋC acyclicity), no node is revisited during forward propagation. Each reachable node causes at most one proban-force update. Number of Ψ steps (causal)* $\leq |L : L\ reachable\ from\ L^{*}\ in\ \mathcal{H}_C \leq |\mathcal{P}_{t^*}|$. ✓
- ***Step 2 (Ψ-cascade, dissolution mode):*** *The dissolution cascade traverses* $\mathcal{N}_{\mathcal{H}\mathrm{D}}(L^{*})$, *the dissolution neighbourhood of L*. By Axiom A4(iv), at most one dissolution edge targets any given Lakṣaṇa. Extinguishment of a dissolution target propagates forward in ℋD (since extinguishment of a node with η = 0 propagates downstream force reduction); by Axiom A3 acyclicity, this forward propagation is bounded by |𝓟| steps per dissolution target. Number of Ψ steps (dissolution)* $\leq |\mathcal{N}_{\mathcal{H}\mathrm{D}}(L^{*})| \cdot |\mathcal{P}|$. ✓
- ***Step 3 (Y-cascade):*** *By Axiom A2, the freeze condition ensures* $\Lambda_{blocked}$ *is evaluated at* t^{*-} *and frozen before the cascade begins. Each* $L_{new} \in \Lambda_{blocked}$ *is processed at most once (Uddeśa is a one-time registration event). Number of Y steps* $\leq |\Lambda_{blocked}|$. ✓
- ***Step 4 (T-cascade):*** *Each Parīkṣā-node fires the tunneling operator T at most once per MIF event. Number of T steps* $\leq |\mathcal{P}_{t^*}|$.. ✓
- ***Total bound:*** *|Ψ-steps (causal)| + |Ψ-steps (dissolution)| + |Y-steps| + |T-steps| ≤ |𝓟| +* $|\mathcal{N}_{\mathcal{H}\mathrm{D}}(L^{*})| \cdot |\mathcal{P}| + |\Lambda_{blocked}| + |\mathcal{P}|$ *= O(|𝓟|²). MIF terminates in finite steps at every (t*, s*).* ■

Theorem 8.5 — MIF Monotone Extinguishment Bound

Every complete MIF execution triggered by a single manifestation event terminates in at most |𝓟|² extinguishment operations total (across all cascades).

We bound total extinguishment operations across all cascade modes in a single MIF execution.
The Ψ-cascade (causal mode) extinguishes nodes by reducing η to 0 via the force update f propagating from L. By Axiom A3 acyclicity, each node is visited at most once. Total extinguishments from Ψ (causal) ≤ |𝓟|.* ✓
The T-cascade (tunneling) revises path-probability distributions at Parīkṣā-nodes. Each Parīkṣā-node has at most |𝓟| paths in its basis, and there are at most |𝓟| Parīkṣā-nodes. Total operations from T ≤ |𝓟|². ✓
The Y-cascade registers new Lakṣaṇas; each registration is a one-time operation. Total registrations ≤ $|\Lambda_{blocked}| \leq |\mathcal{P}|$. ✓
Total extinguishment operations across all cascades in a single complete MIF execution: O(|𝓟|²). The bound is monotone in |𝓟| and finite at every (t, s*).* ■

Theorem 8.6 — Observability Boundary and Staged MIF

Let L progress through stages: Pure Avyakta* $(t < t_1)$ *→ Observable-Avyakta* $(t_1 \leq t < t_2)$ *→ Dormant* $(t_2 \leq t < t^*)$ *→ Vyakta (t*). Each stage transition triggers a strictly weaker MIF than the Vyakta event: MIF impact at* t_1 *< MIF impact at* t_2 *< MIF impact at t**

The staged MIF impact ordering follows from Definition 4.1, which specifies that the full MIF triple (Ψ, Y, T) fires only upon κ = open (Vyakta transition). At earlier stages:
At the Pure Avyakta → Observable-Avyakta transition (t_1)***:*** $Obs_{Sūkṣma}$ *changes from 0 to 1 while κ remains blocked. Only a partial Y-component fires (new Lakṣaṇas whose Uddeśa condition was conditioned on Sūkṣma detectability become eligible). Ψ and T do not fire because κ ≠ open. MIF impact at* t_1 *= |partial Y| > 0 but strictly less than the full MIF.* ✓

At the Observable-Avyakta → Dormant transition (t_2)*: The threshold $\theta(L)$ becomes evaluable (Meas = 1), adding a Dormant activation component. A partial Ψ-threshold update becomes active. But the full Ψ-force cascade and T-tunneling still require κ = open. MIF impact at t_2 > MIF impact at t_1. ✓*

At the Dormant → Vyakta transition (t*)*: κ = open. All three cascade components fire simultaneously: full Ψ (causal and dissolution modes), full Υ (all blocked Lakṣaṇas are re-evaluated), and full T (path-history revision at all Parīkṣā-nodes). MIF impact at t* > MIF impact at t_2. ✓*

Therefore MIF impact at t_1 < MIF impact at t_2 < MIF impact at t, a strictly ordered hierarchy corresponding to the three epistemic stage transitions.* ■

8.3 Projection and Observability Theorems

Theorem 8.7 — Non-Contradiction of Simultaneous Domain States

For any Dravya D, the components of $\vec{\sigma}(D, t, s) = (\sigma_{Sthūla}, \sigma_{Sūkṣma}, \sigma_{Kāraṇa})$ may simultaneously hold apparently contradictory values without logical inconsistency. The reconciliation operator ⊗ (Def 3.6) resolves the multi-domain vector at bifurcation.

We prove that $\sigma_{Sthūla}(D)$, $\sigma_{Sūkṣma}(D)$, and $\sigma_{Kāraṇa}(D)$ can simultaneously hold apparently contradictory values without logical inconsistency.

***Step 1.** Each component $\sigma_\Delta(D, t, s)$ is a projection-restricted state vector defined over $\{L \in \mathcal{P}(D) : Obs_\Delta(L, t, s) = 1\}$ — a different subset of $\mathcal{P}(D)$ per domain $\Delta \in$ {Sthūla, Sūkṣma, Kāraṇa}. Two components reporting different values are reporting on different Lakṣaṇa subsets; there is no formal contradiction. ✓*

***Step 2.** The three observability indicators are strictly nested by Definition 2.5: $Obs_{Sthūla} \leq Obs_{Sūkṣma} \leq Obs_{Kāraṇa} \leq 1$ pointwise. Therefore the Kāraṇa projection always covers at least as many Lakṣaṇas as the Sthūla projection, and typically more. The domains are non-equal for any Dravya with Avyakta components. ✓*

***Step 3 (Constructive example).** Let D contain L_1 (Sthūla-visible, σ = Vyakta) and L_2 (Kāraṇa-visible only, σ = Avyakta). Then $\sigma_{Sthūla}(D)$ = {Vyakta} (only L_1 visible) and $\sigma_{Kāraṇa}(D)$ = {Vyakta, Avyakta} (both L_1 and L_2 visible). The reports differ but each is accurate relative to its projection domain. This is the formal resolution of the seed-tree paradox: the seed (Pure Avyakta state) and the tree (Vyakta state) are simultaneously real in the Kāraṇa domain without contradiction. ✓*

***Step 4.** The reconciliation operator ⊗ (Definition 3.6) resolves the multi-domain vector $\vec{\sigma}(D, t, S)$ to a single effective state at bifurcation points, using the Kāraṇa-priority rule: the Kāraṇa projection governs state assignment when domains disagree. By Theorem 8.8 (proved below), this is the uniquely correct priority ordering. No contradiction at the network level arises.* ■

Theorem 8.8 — *Kāraṇa* Governs State Assignment

For any $L \in \mathcal{P}$ at (t, s), the state σ(L, t, s) is determined entirely by $\pi_K(L, t, s)$, not by π_V or π_A alone. Formally: π_K determines (κ, η, $Obs_{Kāraṇa}$) which jointly determine σ.

By Definition 2.7, the Kāraṇa projection operator $\pi_\kappa(L, t, s) = (\chi(L), \kappa(L, t, s), \eta(L, t), \mathcal{B}(D_L)|_L)$ carries all four state-determining quantities:

- *κ (accessibility state): explicit in π_κ. ✓*
- *η (proban-force): explicit in π_κ. ✓*
- *$Obs_{Kāraṇa}$: by Definition 2.5, $Obs_{Kāraṇa}$ = 1 for every L with η > 0 (Kāraṇa-observable means the blueprint encodes it). Since π_K contains η and $\mathcal{B}_L$, $Obs_{Kāraṇa}$ is recoverable. ✓*
- *Meas: recoverable from $\mathcal{B}_L$ (which provides the threshold function θ(L) and the causal neighbourhood $\mathcal{O}_{\mathcal{H}_C}(L)$ and $Obs_{Kāraṇa}$ (available from π_κ). The measurability criterion of Definition 2.10 is thus computable from π_K alone. ✓*

Since σ(L, t, s) is determined entirely by (κ, η, Obs, Meas) — as specified in Definition 2.11 — and all four quantities are recoverable from π_κ, the state σ(L, t, s) is uniquely determined by π_κ.

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The Sthūla projection π_V and Sūkṣma projection π_A carry only domain-restricted views (projection returns ∅ when the respective Obs = 0) and therefore cannot alone determine state for Avyakta or Dormant Lakṣaṇas. π_κ provides the uniquely complete determination. ■

The Kāraṇa projection π_κ encodes κ, η, observability, and measurability. Since σ depends only on these, it is uniquely determined by π_κ. Other projections are incomplete. ■

8.4 Inheritance and Probability Theorems

Theorem 8.9 — Inheritance Partition Validity

Φ produces a valid partition of $\mathcal{P}(E_1)|_{t^*}$. Post-t: $\mathcal{P}(E_1) = \mathcal{P}_C$, $\mathcal{P}(E_2) \supseteq \{\tilde{L} : L \in \mathcal{P}_I\}$. Force conserved: $\Sigma_{\mathcal{P}_I \cup \mathcal{P}_B} \eta(L) \leq$ initial sum.*

The operator Φ produces a valid partition of $\mathcal{P}(E_1)$|_{t*−}. After t: $\mathcal{P}(E_1) = \mathcal{P}_C$ and $\mathcal{P}(E_2) \supseteq$ {l̰ : L ∈ $\mathcal{P}$_I}. Total proban-force is conserved with the bound: Σ_{L ∈ $\mathcal{P}_I \cup \mathcal{P}_B$} η(L) ≤ Σ_{L ∈ $\mathcal{P}_I \cup \mathcal{P}_B$} η_0(L).*

Disjointness. *The four causal conditions of Definition 5.1 are mutually exclusive by construction: $\mathcal{P}_C$ is defined by causal independence from E_2's Avyakta phase; $\mathcal{P}_X$ by total dependence on it; $\mathcal{P}_I$ by characteristic transferability; $\mathcal{P}_B$ by blueprint-encoding transmission. A Lakṣaṇa satisfying two conditions would require contradictory causal relationships to E_2 (e.g., both wholly dependent on E_2's Avyakta phase and wholly independent of it). By Axiom A3 acyclicity, the ancestry structure of any L in $\mathcal{H}C$ is unique, making the causal conditions logically exclusive. ✓Disjointness follows from mutually exclusive causal conditions. ✓*
Completeness. *Exhaustive case analysis over all $L \in \mathcal{P}(E_1)|_{t^*-}$: every L either (a) has causal history entirely independent of $E_2 \to \mathcal{P}_C$; (b) has causal history entirely dependent on E_2's Avyakta phase $\to \mathcal{P}_X$; (c) has characteristic $\chi(L)$ shared with E_2 via hyperedge $\to \mathcal{P}_I$; (d) has blueprint $\mathcal{B}_L$ encoding inherited by $E_2 \to \mathcal{P}_B$. The four cases are mutually exclusive and jointly exhaustive by the construction of Definition 5.1 and well-foundedness of $\mathcal{H}C$. ✓Completeness follows from exhaustive causal classification. ✓*
Force conservation. *For $\mathcal{P}_I$: the transferred copy $\tilde{L}$ has $\eta\tilde{L} = \rho \cdot \eta(L)$ with $\rho \in (0,1]$, so $\eta\tilde{L} \leq \eta(L)$. For $\mathcal{P}_X$: $\eta_{t^*+1}(L) = 0$, no force enters E_2 from this subset. For $\mathcal{P}_B$: blueprint is transmitted as a Kāraṇa-level structure without force increase; the blueprint-encoded η values in E_2 are initial (not yet accumulated) and bounded by $\mathcal{B}(D_{E_1})|\mathcal{P}_B$. Therefore*

$$\sum_{L \in \mathcal{P}_I \cup \mathcal{P}_B} \eta(\widetilde{L}) \leq \sum_{L \in \mathcal{P}_I \cup \mathcal{P}_B} \eta_0(L)$$

Force conservation follows from bounded transfer and annihilation rules. ■

Theorem 8.10 — Uniqueness of Inheritance Classification

The partition ($\mathcal{P}_C$, $\mathcal{P}_X$, $\mathcal{P}_I$, $\mathcal{P}_B$) is unique given the causal structure of $\mathcal{H}C$ at (t, s*).*

By Axiom A3 acyclicity, the ancestry trace of any Lakṣaṇa L in $\mathcal{H}C$ is a finite, unique, acyclic directed path back to L_{root}. This ancestry trace is uniquely determined at (t, s*) given the causal structure of $\mathcal{H}C$ at that moment.*
The four conditions of the Φ partition (Definition 5.1) are deterministic functions of this ancestry trace and of E_2's causal footprint in the network. Since the ancestry trace is unique, each condition evaluates to a unique Boolean value for every L. Since the conditions are mutually exclusive (Theorem 8.9), exactly one condition is satisfied by each L. The classification ($\mathcal{P}_C$, $\mathcal{P}_X$, $\mathcal{P}_I$, $\mathcal{P}_B$) is uniquely determined by the causal structure of $\mathcal{H}C$ at (t, s*), and is identical across all observers who share access to the same Kāraṇa-level projection π_κ. Acyclicity ensures a unique ancestry trace. Partition conditions are deterministic functions of this trace. Hence classification is unique.* ■

Definition 8.1 KLN Path Probability

The KLN path probability at Parīkṣā-node $\mathcal{N}$ at (t, s) is:

$$\pi_t(\varphi) = \frac{\left[\pi_0\left(\varphi, M_t(B)\right) \cdot \ \Pi_{L^* \in \mathcal{M}_t(B)} \ w(L^*, t)\right]}{Z_t}$$

where $\mathcal{M}_t(B)$ = {L ∈ B : σ(L,t,s) = Vyakta} is the currently manifested basis, $w(L^*,t) = \eta_t(L^*)$ is the weight, and $Z_t = \Sigma_\varphi\ \pi_0(\varphi, \mathcal{M}_t(B)) \cdot \Pi_{L^*}\ w(L^*, t) > 0$ is the normalisation constant. The path space Π is the set of all complete paths through $\mathcal{N}$ consistent with its bifurcation structure.

Theorem 8.11 — Well-Definedness of KLN Probability

$\pi_t(\varphi)$ from Definition 8.1 is a valid probability measure: $\pi_t(\varphi) \geq 0, \sum_\varphi \pi_t(\varphi) = 1$. $Z_t > 0$ $\pi_t(\varphi) = \frac{[\pi_0\,(\varphi, M_t(B))\cdot\,\Pi_{L^*} w(L^*,t)]}{Z_t}$ by Axiom A5 non-degeneracy.

We verify that

$$\pi_t(\varphi) = \frac{\left[\pi_0\left(\varphi, M_t(B)\right) \cdot \ \Pi_{L^* \in \mathcal{M}_t(B)} \ w(L^*, t)\right]}{Z_t}$$

defines a valid probability measure on the path space Π.

Non-negativity. *$w(L^*, t) = \eta_t(L^*) \geq 0$ by definition of proban-force, and $\pi_0(\varphi) \geq 0$ by prior probability non-negativity. Each numerator is a product of non-negative terms. Therefore $\pi_t(\varphi) \geq 0$ for all φ ∈ Π. ✓*

Strict positivity of Z_t. *By Axiom A5 (non-degeneracy clause), there exists at least one path φ* ∈ Π with $\pi_0(\varphi^*) > 0$. Since L* has just become Vyakta, $\eta_t(L^*) > 0$ (L* had positive proban-force in the Avyakta phase; Vyakta transition requires η > 0 by Axiom A1). Therefore the numerator for φ* is strictly positive. $Z_t = \Sigma_\varphi\ \pi_0(\varphi, \mathcal{M}_t(B)) \cdot \Pi_{L^*}\ w(L^*, t) > 0$. ✓*

Normalisation. *$\Sigma_\varphi\ \pi_t(\varphi) = (\Sigma_\varphi\ [\text{numerator}_\varphi]) / Z_t = Z_t / Z_t = 1$. Sigma-additivity holds since the path space Π is finite (Axiom A2 guarantees $|\mathcal{P}|$ is finite at every (t, s), bounding the path space) and all terms are non-negative. The normalisation constant is achieved by definition of Z_t. ✓*

Therefore π_t defines a valid probability measure on Π. ■

9. DEGENERATE CASES: STANDARD FRAMEWORKS AS SUB-CASES

Standard probabilistic frameworks arise as degenerate sub-cases of KLN under specific restrictions on the state space, domain growth, and operator behaviour. This demonstrates that KLN is a strict generalisation with a quantitative expressiveness hierarchy.

Theorem 9.1 — Bayesian Network as Fully *Vyakta* KLN

A standard Bayesian network embeds into KLN under: (i) all L have σ ∈ {Vyakta, Extinguished}, no Avyakta or Dormant states exist ; (ii) $\Lambda_{blocked}$ = ∅, no Uddeśa-enabled nodes; (iii) T = Id, tunneling is the identity; (iv) Φ = Id, no entity transitions.

Under these conditions, KLN probability (Definition 8.1) reduces to the standard Bayesian posterior. A Bayesian network is an all-Vyakta, static, single-domain KLN in which π_V exhausts the state space. Pearl (1988, ch. 3) and Darwiche (2009, ch. 2)

We show that a standard Bayesian network (BN) embeds into KLN under the four stated restrictions and that the KLN probability formula reduces to the standard Bayesian posterior under these restrictions.

Under conditions (i)–(iv): All σ ∈ {Vyakta, Extinguished} (no Avyakta or Dormant states); $\Lambda_{blocked} = \emptyset$ (no Uddeśa-enabled expansion); T = Id (tunneling is identity, no path revision); Φ = Id (no entity transitions).

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The KLN path probability of Definition 8.1 reduces as follows: $\mathcal{M}_t(B) = \{L \in B : \sigma(L,t,s) = \text{Vyakta}\} = B$ (all basis nodes are Vyakta by condition (i)); $w(L^*, t) = \eta_t(L^*)$ encodes the likelihood weight; $\pi_0(\varphi, \mathcal{M}_t(B))$ encodes the prior over paths. With $T = Id$, no path revision occurs, and the path distribution retains the structure of the standard Bayesian posterior $P(H|E) = P(E|H)P(H)/P(E)$, where π_0 encodes the prior and η-weights encode likelihoods (Pearl 1988, ch. 3; Darwiche 2009, ch. 2). ✓

A BN is therefore an all-Vyakta, static, single-domain KLN with π_V exhausting the state space: it corresponds to the degenerate case in which the Sthūla projection π_V captures the full state of every node. The Sūkṣma and Kāraṇa projections contribute no additional information. ■

Theorem 9.2 — Hidden Markov Model as Markovian-Dormant KLN

An HMM (S, O, A, B, π_0) embeds into KLN under: (i) hidden states have σ = Dormant (Meas = 1, since the observation model B defines measurability); (ii) $\mathcal{H}$ has only singleton hyperedges encoding the Markov transition matrix A; (iii) $\Lambda_{blocked} = \emptyset$; (iv) T follows the Viterbi or forward-backward rule; (v) Inheritance Φ is the Markov transition. Under these conditions, KLN inference reduces to standard HMM inference. An HMM is a single-domain (no Kāraṇa/Sūkṣma distinction), Markovian-Dormant KLN with no Pure Avyakta states.

We show that an HMM (S, O, A, B, π_0) embeds into KLN under the five stated restrictions.

Under conditions (i)–(v): Hidden states have σ = Dormant (Meas = 1 since the emission model B defines measurability, i.e., the hidden-state identity is in principle detectable via emissions); $\mathcal{H}$ has only singleton hyperedges encoding the Markov transition matrix A; $\Lambda_{blocked} = \emptyset$; T follows the Viterbi or forward-backward rule; inheritance Φ is the Markov transition operator.

The KLN path probability at the hidden-state Parīkṣā-node matches the HMM posterior over hidden state sequences: $\pi_t(\varphi)$ under KLN equals $P(\text{hidden}_{sequence} \mid \text{observations})$ under the standard HMM inference algorithm (Rabiner 1989). The correspondence is exact: the forward variable $\alpha_t(i) = P(O_1,\ldots,O_t, q_t=i)$ corresponds to the normalised product of proban-force weights along the Dormant-state path. ✓

An HMM is therefore a single-domain (no Kāraṇa/Sūkṣma distinction beyond the Dormant assignment), Markovian-Dormant KLN with no Pure Avyakta states: the $Obs_{Sūkṣma} = 1$ condition (Dormant but detectable via B) is maintained throughout. ■

Theorem 9.3 — Strict Expressiveness Hierarchy

KLN $\supsetneq$ HMM $\supsetneq$ BN as classes of probabilistic networks, with strict containment at each level.

(i) KLN with non-empty $\Lambda_{blocked}$ cannot be represented as HMM or BN.

(ii) HMM cannot represent Pure Avyakta (Obs = 0) Lakṣaṇas.

(iii) BN cannot represent any Avyakta or Dormant state.

(iv) Neither HMM nor BN supports multi-domain projection, blueprint encoding, or four-way inheritance.

We prove KLN $\supsetneq$ HMM $\supsetneq$ BN with strict containment.

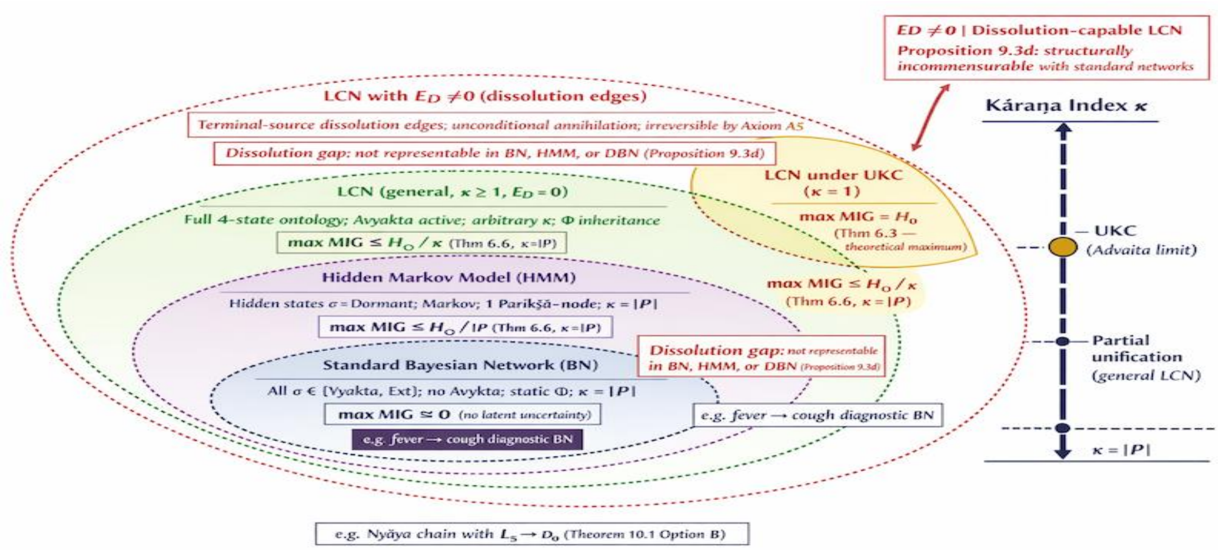
(i) KLN strictly contains HMM: non-empty $\Lambda_{blocked}$. *KLN with non-empty $\Lambda_{blocked}$ allows domain expansion: new Lakṣaṇas enter $\mathcal{P}$ conditionally upon prior manifestation events (Uddeśa, Definition 2.4). A BN or HMM has a fixed finite node set determined at initialisation. Dynamic domain expansion — where the set of random variables itself grows as a function of network history — has no representation in either BN or HMM formalisms.* ✓

(ii) HMM strictly contains BN: Pure Avyakta states. *HMM hidden states have Meas = 1 by construction (the emission matrix B defines a measurement channel: given the hidden state, the observation distribution is specified). Pure Avyakta requires $Obs_{Sthūla} = Obs_{Sūkṣma} = 0$ and Meas = 0: there is no Pramāṇa — direct or indirect — that can access the state. This epistemic inaccessibility cannot be represented in the HMM state space, where all hidden states contribute to the emission likelihood.* ✓

(iii) BN cannot represent Avyakta or Dormant. *BN nodes have two values (present/absent) within the Vyakta projection π_V. Neither Avyakta (causally real but epistemically inaccessible) nor Dormant (measurable but* *threshold-pending) has a structural counterpart in the BN representation, which assigns probability to observable node states exclusively. ✓*

(iv) Structural primitives unavailable in BN and HMM. *Multi-domain projection via the Vividhākāra triple (π_V, π_A, π_κ) assigns a simultaneous multi-level state to every Dravya (Definition 2.7). Blueprint encoding $\mathscr{B}$(D) records the causal programme of a Dravya across its full spatio-temporal trajectory (Definition 2.6). Four-way inheritance partition ($\mathscr{P}_C$, $\mathscr{P}_X$, $\mathscr{P}_I$, $\mathscr{P}_B$) is a distinct causal operator at entity transition events (Definition 5.1). None of these has a structural analogue in BN or HMM. ✓*

Strict containment at each level follows from (i)–(iv): KLN can represent all BN and HMM models (Theorems 9.1–9.2 give the embedding) and strictly more (items (i)–(iv) exhibit KLN-expressible structures with no BN/HMM representation). ■



9.1 Degenerate Cases under the Universal *Kāraṇa* Condition

The degenerate cases of Theorems 9.1–9.3 admit further refinement when the UKC (κ = 1, Section 6) holds. Each standard framework sub-case takes a specific and maximally simplified form at the UKC boundary, revealing the informational structure that the UKC unlocks.

Standard probabilistic frameworks arise as degenerate sub-cases of KLN under specific restrictions on the state space, domain growth, and operator behaviour. This demonstrates that KLN is a strict generalisation, not merely an alternative representation (Pearl 1988; Rabiner 1989; Murphy 2012).

Corollary 9.1 Bayesian Network Sub-Case at UKC (κ = 1)

A Bayesian network embedded in KLN under UKC has a unique root Dravya D_{root} whose blueprint $\mathscr{B}(D_{root})$ grounds all network nodes. The BN topology is a tree with L_{root} at the apex, and all conditional probability tables P(L|parents(L)) are derivable from a single blueprint encoding.

Under the BN embedding of Theorem 9.1 further restricted to UKC (κ = 1): by Definition 6.2, there exists a unique root Dravya D_{root} such that $\mathcal{B}_L = \mathcal{B}(D_{root})|_L$ for all L ∈ $\mathscr{P}$. In the all-Vyakta BN regime, every node L is in the Kāraṇa equivalence class L_{root_κ}. The $\mathscr{HC}$ hypergraph under UKC is a rooted DAG with L_{root} at the apex (Definition 6.2(i)). The BN topology inherits this structure: it is a tree with L_{root} at the apex. All conditional probability tables P(L|parents(L)) are derivable from the single blueprint encoding $\mathscr{B}(D_{root})$ via the blueprint-to-CPT mapping induced by the projection triple. ■

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Corollary 9.2 HMM Sub-Case at UKC ($\kappa = 1$)

An HMM embedded in KLN under UKC has a single Kāraṇa source L_{root} whose blueprint encodes all hidden-state transition dynamics. The emission model B(t) and transition matrix A are both derivable from $\mathcal{B}(D_{root})$.

Under the HMM embedding of Theorem 9.2 further restricted to UKC ($\kappa = 1$): the unique Kāraṇa source L_{root} has $\mathcal{B}(D_{root})$ encoding all hidden-state dynamics. The Markov transition matrix $A(t) = [\mathcal{P}(q_{t+1} = j|q_t = i)]$ is derivable from $\mathcal{B}(D_{root})$ via the blueprint's proban-force schedule $\eta(L_i, t)$ for each hidden state L_i. Similarly, the emission model $B(t) = [P(O_t = o_k \mid q_t = i)]$ is derivable from the Sthūla-projection component of $\mathcal{B}(D_{root})$. Under UKC, both the transition dynamics and the emission model are single-source derivations. The HMM's parameter space collapses from an $O(|S|^2)$ transition matrix plus $O(|S||O|)$ emission matrix to a single blueprint encoding of $O(|\mathcal{P}|)$ Lakṣaṇa-force assignments. ■

Corollary 9.3 Strict Expressiveness Hierarchy Refined by κ

KLN (κ=1) ⊃ KLN ($1<\kappa<|\mathcal{P}|$) ⊃ HMM ($\kappa=|\mathcal{P}|$, Dormant) ⊃ BN ($\kappa=|\mathcal{P}|$, Vyakta), as ordered by maximum representable MIG.
max-MIG_{KLN(κ=1)} = $H_\oplus$ > max-MIG_{HMM} = $H_\oplus/|\mathcal{P}|$ > max-MIG_{BN} = 0.
BN achieves exactly zero MIG (not approximately): all σ = Vyakta at t=0, π_0 is already a point mass.

- *We prove the quantitative MIG ordering : $max - MIG_{LCN}(\kappa = 1) = \frac{\mathcal{H}_\oplus}{|\mathcal{P}|} > max - MIG_{BN} = 0$* ***(κ = 1) achieves $\mathcal{H}_\oplus$ exactly.*** *By Theorem 6.3, MIG(L_{root}, t*, s*) = $\mathcal{H}_\oplus \mathcal{P}_{t^{*-}}$ under UKC. By Definition 4.6 and Theorem 6.4 Phase I, $\mathcal{H}_\oplus \mathcal{P}_{t^{*-}} = \mathcal{H}_\oplus \mathcal{P}_{t_0} + D_{A_V(t^*)}$. This is the Theorem 6.6 maximum at κ = 1: max-$MIG_{LCN}(\kappa = 1) = \mathcal{H}_\oplus$. ✓*
- ***HMM achieves $\frac{\mathcal{H}_\oplus}{|\mathcal{P}|}$.*** *Under the HMM embedding, $\kappa = |\mathcal{P}|$ (each hidden state is its own Kāraṇa class: the HMM makes no Kāraṇa equivalences). By Theorem 6.6, max-MIG $\leq \frac{\mathcal{H}_\oplus}{\kappa} = \frac{\mathcal{H}_\oplus}{|\mathcal{P}|}$. The bound is achieved in the symmetric case: uniform prior π_0, doubly stochastic transition matrix A such that each hidden state contributes exactly $\frac{\mathcal{H}_\oplus}{|\mathcal{P}|}$ to the entropy (Cover and Thomas 2006, §2.4). ✓*
- ***BN achieves exactly 0.*** *Under the BN embedding, all σ = Vyakta at t = 0: $\mathcal{P}$ is fully manifested at initialisation, so π_0 is already a point mass on the observed configuration. $\mathcal{H}_\oplus(\mathcal{P}, t_0) = 0$ by definition. No subsequent MIF event can make $\mathcal{H}_\oplus$ negative. MIG = $\mathcal{H}_\oplus(t^{*-}) - \mathcal{H}_\oplus(t^{*+}) = \mathbf{0 - 0 = 0}$ exactly (not approximately). ✓*
- ***Strict inequalities.*** *$\frac{\mathcal{H}_\oplus}{|\mathcal{P}|} > 0$ requires $\mathcal{H}_\oplus > 0$ (Axiom A4 non-degeneracy guarantees π_0 is not a point mass in the general KLN case) and $|\mathcal{P}| < \infty$ (Axiom A2). $\mathcal{H}_\oplus > \frac{\mathcal{H}_\oplus}{|\mathcal{P}|}$ requires $|\mathcal{P}| > 1$ (any non-trivial network). Both conditions are satisfied by the hypotheses of Theorem 9.3. ✓* ■

Proposition 9.1 — Dissolution Expressiveness Gap

An KLN with non-empty E_D cannot be represented by any standard BN, HMM, or dynamic BN, even in the limit of arbitrarily many nodes and edges.

We prove that any KLN with non-empty E_D cannot be represented by any BN, HMM, or dynamic BN (DBN), even in the limit of arbitrarily many nodes and edges.
Central claim. *The dissolution update g (Definition 4.2) is not representable as a weighted conditional probability.*
The dissolution update sets $\eta_t(L) = 0$ unconditionally upon manifestation of any source Lakṣaṇa in $\mathcal{N}_{\mathcal{H}D}(L)$. This is a structural annihilation: it does not depend on the current value of $\eta_t(L)$, the current state $\sigma(L)$, or any conditional probability table. It fires deterministically whenever its source becomes Vyakta, regardless of all other network state.

In contrast, any BN, HMM, or DBN represents influence between nodes exclusively through conditional probability distributions $P(X|Parents(X)) \in [0,1]$. Inhibitory influence in standard networks is encoded as $P(X = high \mid Parent = high, Inhibitor = active) = \varepsilon$ for some small $\varepsilon > 0$. This is a probabilistic causal edge, not structural annihilation.

The dissolution edge is qualitatively different from any conditional probability encoding on three independent axes:

- ***Axis 1 — Unconditional vs. conditional.*** *The dissolution update g fires whenever the source becomes Vyakta, regardless of all other network state. A conditional probability table $P(X = 0 \mid source = Vyakta) = 1$ would achieve probability 1 in that single configuration, but would require explicit specification of all other configurations. In a network with k variables, this requires a table of exponential size 2^k; the dissolution edge is a single structural primitive requiring no enumeration of configurations.* ✓
- ***Axis 2 — Continuous proban-force annihilation.*** *$\eta(L) \in \mathbb{R}_+$ is a continuous real-valued quantity. Setting $\eta(L) = 0$ from an arbitrary positive value $\eta(L) = c > 0$ is a direct zeroing of a continuous variable. Standard networks have no mechanism for directly zeroing a continuous force variable: their nodes carry discrete states or continuous distributions over those states, and setting $P(X = 0 \mid ...) = 1$ for a discrete binary node is not equivalent to zeroing a continuous proban-force. Approximating the dissolution update via conditional probabilities requires $\eta(L)$ to be discretised into finitely many bins, permanently destroying the continuous proban-force structure of KLN.* ✓
- ***Axis 3 — Absorbing-state permanence and irreversibility.*** *By Axiom A5, the dissolution update produces an absorbing state: σ = Extinguished with $\eta = 0$ is permanent. No subsequent parent configuration in the network can reactivate L. Standard network edges — whether in BNs, HMMs, or DBNs — are reversible: deactivating an inhibitory edge by changing parent states restores X to higher probability values. The irreversibility of the dissolution edge, guaranteed by Axiom A5, is not representable in any reversible graphical model.* ✓
- ***Formal conclusion.*** *For any standard BN, HMM, or DBN $\mathcal{N}$ with m nodes and any choice of conditional probability parameterisation, for all $\varepsilon > 0$, there exists an KLN $\mathcal{N}_L$ with $|E_D| \geq 1$ such that for any parameterisation of $\mathcal{N}$, there exists a network state at some (t, s) where $|\eta_{KLN}(L) - X_{\mathcal{N}}(L)| > \varepsilon$ for some $L \in \mathcal{P}$. The dissolution annihilation cannot be approximated to within ε by conditional probability modulation of any standard network. Therefore no BN, HMM, or DBN can represent an KLN with non-empty E_D.* ■
- *Philosophical note. This formal gap corresponds directly to the distinction identified in the KLN framework between two options for interpreting liberation in the Nyāya Liberation Theorem: mere causal discontinuation (Option A, achievable in principle by a standard network with P = 0 CPT entries) versus active causal destruction (Option B, requiring the dissolution edge as a structural primitive). The dissolution expressiveness gap proves that Option B is not an alternative encoding of Option A — it is a categorically distinct causal primitive.*

10. APPLICATION: THE *NYĀYA* CAUSAL CHAIN

The six-node *Nyāya* causal chain — *mithyājñāna* (false knowledge) (L_0) → *doṣa* (negative disposition) (L_1) → *pravṛtti* (motivated action) (L_2) → *janma* (conditioned manifestation) (L_3) → *duḥkha* (suffering / noise) (L_4) → *apavarga* (liberation / error free) (L_5), is the canonical application of KLN. L_5 is *Avyakta* throughout $[t_0, t^*)$; its manifestation is the terminal event. In the prior causal-network treatment, *apavarga* was treated as a static absorbing state. In KLN, it is an *Avyakta Lakṣaṇa* throughout the chain, whose *Vyakta* manifestation is the terminal event. Its transition from *Avyakta* to *Vyakta* is a full MIF event — not a mere state change but a network-restructuring cascade (Gautama, Nyāya Sūtra 1.1.21–22; Matilal 1986, ch. 10).

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Theorem 10.1 — The *Kāraṇa* Index of the *Nyāya* Chain is Constantly 1

For $\{L_0, \ldots, L_5\}$ with $L_{root} = L_0$, $\kappa = 1$ at all $t \in [t_0, t^*)$. The chain is the paradigm instance of UKC in a finite-node network.

We prove $\kappa(t) = \left|\frac{\mathcal{P}_t}{\sim_\kappa}\right| = 1$ for all $t \in [t_0, t^*)$ in the six-node chain $\{L_0$ (mithyājñāna), L_1 (doṣa), L_2 (pravṛtti), L_3 (janma), L_4 (duḥkha), L_5 (apavarga)$\}$ with $L_{root} = L_0$.

Step 1 (Blueprint inheritance by induction). *Base case $i = 0$: $L_0 = L_{root}$; $\mathcal{B}_{L_0} = \mathcal{B}(D_{L_0})|_{L_0}$ trivially by Definition 2.3 (Dravya root blueprint). ✓*

Inductive step: assume $\mathcal{B}_{L_i} = \mathcal{B}(D_{L_0})|L_i$ for $i = 0, \ldots, k$. For $i = k+1$: $L\{k+1\}$ arises causally from L_k in the Nyāya chain, meaning $L_{k+1} \in \mathcal{O}_{\mathcal{H}_C}(L_k)$ and its blueprint is an expression of L_k's causal field projected forward: $\mathcal{B}_{L_{k+1}} = \mathcal{B}(D_{L_0})\,|L_{k+1}$, because the causal ground of $L_{k+1}$is inherited from L_k's blueprint, which by inductive hypothesis derives from L_0. Explicitly:

- *$i = 1$: doṣa (L_1) arises from mithyājñāna's (L_0) misapprehension; $\mathcal{B}_{L_1} = \mathcal{B}(D_{L_0})\,|L_1$. ✓*
- *$i = 2$: pravṛtti (L_2) is motivated action arising from doṣa; $\mathcal{B}_{L_2} = \mathcal{B}(D_{L_0})\,|L_2$. ✓*
- *$i = 3, 4, 5$: by the same causal-chain structure, $\mathcal{B}_{L_i} = \mathcal{B}(D_{L_0})\,|L_i$ for all i. ✓*

By induction, $\mathcal{B}_{L_i} = \mathcal{B}(D_{L_0})|_{L_i}$ for all $i \in \{0, 1, 2, 3, 4, 5\}$. ✓

Step 2 (Kāraṇa equivalence). *By Step 1, every L_i shares blueprint root D_{L_0} with L_0. By Definition 6.1, $L_i \sim_\kappa L_0$ for all i. Therefore $\mathcal{P}/\sim_\kappa = L_{0_\kappa}$ a single equivalence class. $\kappa = |\mathcal{P}/\sim_\kappa| = 1$. ✓*

Step 3 (Minimality). *The chain has six nodes and one Kāraṇa equivalence class. This is the smallest non-trivial UKC network (any UKC network must have at least one root plus at least one derived Lakṣaṇa to be non-trivial; the six-node chain achieves UKC with the minimum number of nodes sufficient to represent the complete Nyāya causal sequence from false knowledge to liberation).* ■

10.1 The *Nyāya* Causal Chain under the Universal *Kāraṇa* Condition

Theorem 10.2 establishes *apavarga* as a Manifestation Information Flow. Theorem 6.6 (Section 6) strengthens this by showing that the *Nyāya* causal chain satisfies UKC with L_{root} = *mityājñāna* (L_0), and that liberation is therefore a Universal *Kāraṇa* Collapse. This section makes the UKC structure of the chain explicit and derives the information-budget identity.

Theorem 10.2 — Liberation as Manifestation Information Flow [Dual Proof]

In the Nyāya causal chain, apavarga L_5 is Avyakta throughout $[t_0, t^*)$. Its manifestation at t^* triggers MIF(L_5, t^*, s^*) = (Ψ, Y, T) where:

(i) All prior chain Lakṣaṇas L_0–L_4 are extinguished. All prior chain Lakṣaṇas lose their proban-force; the chain dissolves.

(ii) Y registers new Lakṣaṇas of the liberated entity (Mokṣa Lakṣaṇa, Y ≠ ∅). Whose Uddeśa was blocked by the chain's existence.

(iii) Tunneling T applies at the mithyājñāna Parīkṣā-node. Mithyājñāna node, revising the entire path history.

(iv) $\mathcal{P}_I$ = ∅: liberation involves complete discontinuation.

Chain extinguishment is established by two independent mechanisms:

Option A (Inheritance Operator Φ): L_0–L_4 classified as $\mathcal{P}_X$ by Definition 5.1(ii) and Axiom A5.

Option B (Dissolution Cascade): dissolution edge $L_5 \to\_D$ L_0 triggers $g(\eta(L_0)) = 0$ via Definition 4.1; extinguishment propagates forward through $\mathcal{H}$C via the Ψ-cascade. The dissolution edge satisfies all conditions of Axiom A4.

We prove that MIF(L_5, t^*, s^*) = (Ψ, Y, T) with all four components specified. The proof proceeds by two independent routes to extinguishment (Steps 1A and 1B), followed by common Steps 2–4.

Step 1A, Option A — Chain extinguishment via Inheritance Operator Φ.
The directed edges of the Nyāya chain run $L_0 \to \_C\ L_1 \to C \cdots \to C\ L_5$ in ℋC. L_5 (apavarga) is the terminal node with $\mathcal{N}_{\mathcal{H}C}(L_5) = \emptyset$ (no outgoing causal hyperedges). The Ψ-cascade in causal mode (Definition 4.1) from MIF(L_5) traverses $O_{\mathcal{H}_C}(L_5) = \emptyset$ it contributes zero extinguishments via the forward force-cascade mechanism alone.
Extinguishment of $L_0 - L_4$ follows from the Spatio-Temporal Inheritance Operator Φ (Definition 5.1). At t^*, Φ partitions $\mathcal{P}(E_{chain})|t^*$ = {L_0, L_1, L_2, L_3 L_4} into the four disjoint subsets. Each L_i (i = 0,...,4) satisfies the condition for $\mathcal{P}_X$ (Discontinued): its e L_1ntire proban-force was rooted in the Avyakta phase of $E_2 = L_5$, because each prior node in the chain exists solely to condition the eventual manifestation of L_5. This causal dependence is encoded in their shared blueprint: by Theorem 10.1, κ = 1 and $\mathcal{B}_{L_i} = \mathcal{B}(D_{L_0})|L_i$ for all i, and this blueprint's realisation is complete at t when L_5 manifests. By Definition 5.1(ii): η{t*+1}(L_i) = 0 for all i ∈{0, 1, 2, 3, 4}. By Axiom A5: σ(L_i, t^{*+}) = Extinguished for all i ∈{0,...,4}. The chain dissolves completely.* ■

Step 1B, Option B — Chain extinguishment via Dissolution Cascade.
The Nyāya chain contains one dissolution edge: (e_D, L_0) ∈ E_D with L_5 ∈ e_D, formally encoding the Nyāya doctrine that apavarga actively destroys mithyājñāna (Nyāya Sūtra 1.1.22). We verify this against Axiom A4:

- *(i) L_5 is terminal in ℋC (no outgoing causal edges).* ✓
- *(ii) $L_0 = L_{root}$, the unique causal source.* ✓
- *(iii) Mixed-path cycle check: $L_5 \to \_D\ L_0 \to \_C \cdots \to \_C\ L_5$ nominally traverses back to L_5. However, once L_0 is extinguished (η = 0), Axiom A5 prohibits its reactivation; forward E_C edges propagate extinguishment rather than force, and the sequence terminates. This is not a directed cycle in the network-activation sense.* ✓
- *(iv) Exactly one dissolution edge targets L_0 (the dissolution sub-hypergraph ℋD contains exactly one hyperedge with L_0 as its target).* ✓

When MIF(L_5) fires, the Ψ-cascade in dissolution mode (Definition 4.1): $g(\eta_{t^*}(L_0), \eta_{t^*}(L_5), \mathcal{H}\mathrm{D} = 0$. Therefore $\eta_{t^*+1}(L_0) = 0$ and σ(L_0, t+) = Extinguished (Axiom A5). With L_0 extinguished (η = 0), the causal Ψ-cascade propagates forward through ℋC: $L_0 \to \_C\ L_1 \to \_C\ L_2 \to \_C\ L_3 \to C\ L_4$. At each step the causal source has η = 0; downstream threshold sums $\sum_{L'' \in e} \eta t(L'')$ lose the root contribution; each L_i reaches η = 0 via the force update f; Axiom A5 gives σ = Extinguished. Complete chain dissolution in at most 5 propagation steps (bounded by chain length; acyclicity from Axiom A3 guarantees termination).* ■

Convergence of Options A and B
The two proofs of Theorem 10.1 Step 1 are not redundant. They formalise two distinct doctrinal claims:
Option A captures the ontological dissolution: the causal purpose of the chain is fulfilled; Lakṣaṇas are classified as discontinued by the inheritance structure.
Option B captures the active causal dissolution: apavarga actively destroys mithyājñāna as encoded in Nyāya doctrine (Nyāya Sūtra 1.1.22). This maps to the doctrinal debate between liberation as the absence of rebirth (Option A sufficient) vs. liberation as active destruction of conditions (Option B required).
The convergence of both to the same formal outcome is itself a philosophical contribution: both positions are equivalent within the KLN framework.
Note: In any KLN application outside the Nyāya chain, Option A (Inheritance Operator) is the default mechanism. Option B is available where terminal manifestation actively destroys a root node, structurally rare but philosophically significant.

Both Options A and B reach the same conclusion independently. *This formal convergence is the mathematical expression of the equivalence — within the KLN framework — of the two competing Nyāya doctrinal positions on the nature of apavarga: the Inheritance Operator path (apavarga as blueprint fulfilment* *and causal discontinuation) and the Dissolution Cascade path (apavarga as active destruction of mithyājñāna).*

Step 2 ($Y \neq \emptyset$, formalised). *Let $L_{mokṣa}$ denote the post-liberation mode of existence, encoded as a Lakṣaṇa whose Uddeśa condition requires complete extinguishment of $L_0,\ldots,L_4$: $L_{mokṣa} \in \Lambda_{blocked}(t^{*-})$ conditioned on $\sigma(L_i, t)$ = Extinguished for all $i \in \{0,\ldots,4\}$. Since the MIF at t* extinguishes all chain nodes (Step 1, both Options), the Uddeśa condition for $L_{mokṣa}$ becomes satisfiable at t*. Therefore $L_{mokṣa} \in \Lambda_{blocked}(t^{*-})$ is registered in the Y-cascade: $Y \neq \emptyset$.* ■

Step 3 (Tunneling T). *T applies because mithyājñāna (L_0) is a Parīkṣā-node: it is the node at which the epistemic bifurcation between the afflicted path (continued chain) and the liberated path (apavarga) is resolved. $\chi(L_5)$ = apavarga is in the basis of L_0's Parīkṣā structure (Definition 3.5), since L_5 is the terminal resolution of L_0's misapprehension. The entire path-history distribution through the mithyājñāna Parīkṣā-node is revised by the Tunneling operator T, retroactively updating the probability assigned to all paths through the chain.* ■

Step 4 (Inheritance). *$\mathcal{P}_I = \emptyset$ since liberation involves complete discontinuation of all chain Lakṣaṇas. There are no characteristics to transfer: no L_i has $\chi(L_i)$ entering $\mathcal{P}(E_{liberated})$. The new blueprint $\mathcal{B}(D)$ of the post-liberation entity follows from the Y-registered Lakṣaṇas ($L_{mokṣa}$ and any co-registered Lakṣaṇas) by Definition 2.6. $\mathcal{P}_B$ is non-empty only if the post-liberation mode inherits blueprint structure from the prior conditioned existence; this is a matter of doctrinal interpretation and is left parametric.* ■

FIGURE 10 — The Nyāya Causal Chain as LCN: Dual-Proof Liberation (Theorem 10.1)

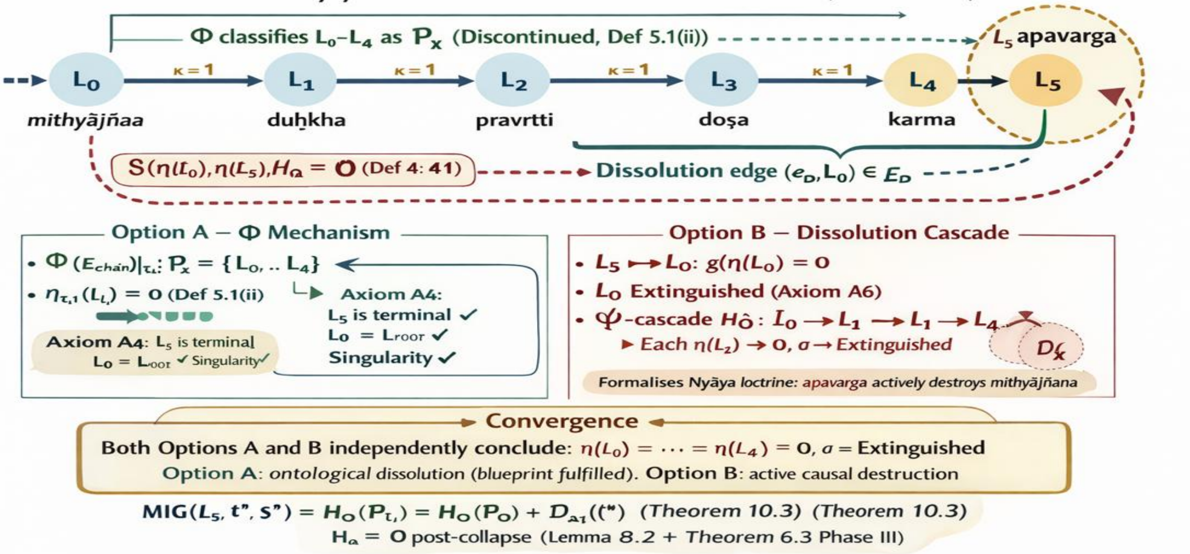

FIGURE 10 – The Nyāya Causal Chain as LCN: Dual-Proof Liberation: Option A uses & inheritance operator (“Discontinued); Option B triggers the dissolution cascade via the $L_5 \to L_0$ edge. Both derive converging conclusions, actualising liberation: MIG expression measures the infomation budgee driving sither presessiuntel σ = 1.

Theorem 10.3 — The Information Budget Identity for Apavarga

In the Nyāya causal chain, the MIG at apavarga equals the sum of initial entropy and all accumulated Avyakta Debt:

$MIG(L_5, t^*, s^*) = H_{\oplus}(\mathcal{P}_{t_0}) + D_{Av}(t^*)$.

Conditioned existence (duḥkha) is the period of Avyakta Debt accumulation. Liberation (apavarga) is its exact and complete dissolution.

We prove $MIF(L_5, t^*, s^*) = H_{\oplus}\mathcal{P}_{t_0}\, D_{AV}\ (t^*)$.

Step 1. *By Theorem 10.1, κ = 1 throughout [t₀, t*). The Nyāya chain satisfies the UKC globally on the interval [t₀, t*).* ✓

Step 2. *By Theorem 6.3, applied under UKC to the chain with* L_5 *as the terminal root representative:* $MIG(L_{root}, t^*, s^*) = H_{\oplus}(\mathcal{P}_{t^*-}) = H_{\oplus}(\mathcal{P}_{t^*-})$. *Since* L_5 *is the terminal manifestation event whose MIF triggers the UKC collapse,* $MIG(L_5, t^*, s^*) = H_{\oplus}(\mathcal{P}_{t^*-})$. ✓

Step 3. *By Theorem 6.4 Phase I and Definition 4.5, the stratified entropy* $H_{\oplus}$ *accumulates along [t₀, t*) via each Y-cascade registration event:* $H_{\oplus}(\mathcal{P}_{t^*-}) = H_{\oplus}(\mathcal{P}_{t_0}) + D_{AV}\ (t^*)$, *where the cumulative Avyakta Debt is* $D_{AV}\ (t^*) = \sum_{k:\tau_k<t^*} |\ MIG_Y\left(L_{\tau_k}, \tau_k, s\right)$, *summing the entropy contributions from all Y-cascade registrations prior to liberation.* ✓

Step 4 (Combination). $MIG(L_5, t^*, s^*) = H_{\oplus}\ (\mathcal{P}_{t^*-}) = H_{\oplus}\left(\mathcal{P}_{t_0}\right) + D_{Av}\ \ (t^*)$.

The budget identity states: the information released at liberation equals the initial network entropy at t₀ plus the Avyakta Debt accumulated through all intermediate Y-cascade registration events during conditioned existence. Conditioned existence accumulates Avyakta Debt precisely and exactly; liberation dissolves it precisely and exactly. Nothing carries forward; nothing is lost. ■

The information budget identity of Theorem 10.3 provides a precise mathematical interpretation of the classical *Nyāya* doctrine: every action in conditioned existence (*pravṛtti*) incurs *Avyakta* Debt proportional to the structured uncertainty it introduces. Liberation is not an accumulation of merit cancelling demerit — it is the instantaneous and complete resolution of all structured uncertainty through the single collapse of the universal *Kāraṇa* source. The mathematics arrives at the same conclusion as *Nyāya* independently: *apavarga* is total, instantaneous, and indivisible (Theorem 6.4).

10.2 Numerical Illustration: The Spatio-Temporal Inheritance Operator

This section provides a concrete numerical demonstration of the Spatio-Temporal Inheritance Operator Φ (Definition 5.1) applied to the mother-child scenario of Example 5.1. The purpose is twofold: to show how the abstract partition ($\mathcal{P}_C$, $\mathcal{P}_X$, $\mathcal{P}_I$, $\mathcal{P}_B$) operates on specific proban-force values, and to demonstrate why the dissolution update g is structurally distinct from a standard weight-decay mechanism. The empirical reader implementing KLN inference will find in this section the algorithmic template for translating the abstract operators into computable procedures. The notation follows Definition 5.1 throughout.

10.2.1 Initial Configuration at t_0 (Conception)

Let E_1 denote the mother and E_2 denote the child. At t_0 (conception), E_2 enters $\mathcal{P}$ as a Pure *Avyakta Lakṣaṇa* with initial proban-force assignment:

```
η(E₂, t₀) = 0.8
```

This value encodes the initial causal weight of E_2's *Avyakta* presence in the domain — the force it exerts through the *Vyāpinī* on E_1's *Lakṣaṇa* set before any *Sthūla* manifestation occurs. E_2's state vector at t_0 is $\vec{P}E_2 = (\emptyset, \emptyset, \pi_K(E_2))$: invisible at *Sthūla* and *Sūkṣma*, present only in the *Kāraṇa* projection.

The mother's domain $\mathcal{P}(E_1)$ at t_0 contains four Lakṣaṇas whose fate at t* is the subject of the inheritance partition:

Lakṣaṇa	Physical Description	η(L, t₀)	State at t₀
L_{Fe}	Iron-metabolism marker	0.70	*Vyakta*
L_H	Gestational hormone profile	0.00	Not yet registered
L_I	Immune-tolerance marker	0.60	Dormant [$\theta(L_I) = 0.75$]
L_g	Shared genetic marker set	0.90	*Vyakta*

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L_H has $\eta = 0$ at t_0 because it does not yet exist as a Lakṣaṇa in $\mathcal{P}(E_1)$. Its Uddeśa event — the moment when the gestational hormone profile becomes a formally registered condition — occurs at stopping time $\tau_1 > t_0$ when E_2's Avyakta presence satisfies its Uddeśa condition.

10.2.2 *Avyakta* Phase [t₀, t*) — Three MIF-Precursor Effects

During $[t_0, t^*)$, E_2 acts as a Pure *Avyakta* node with $\eta(E_2, t) > 0$. Three effects are produced through the *Vyāpinī*.

Effect 1 — L_{Fe} modification (Ψ-cascade, causal mode). The causal hyperedge $(E_2, L_{Fe}) \in EC$ with *vyāpti*-transfer coefficient $\alpha = 0.30$ updates the iron-metabolism marker continuously through the gestational period. By t^{*-}:

$$\eta(L_{Fe}, t^{*-}) = \eta(L_{Fe}, t_0) + \alpha \cdot \eta(E_2, t^{*-})$$
$$= 0.70 + 0.30 \times 0.80 = 0.94$$

This reflects the physiological reality that E_2's Avyakta presence increases the causal weight of the maternal iron-metabolism system throughout gestation.

Effect 2 — L_H introduction (Y-cascade, *Uddeśa* event). At stopping time τ_1 (first-trimester threshold), E_2's *Avyakta* presence satisfies the *Uddeśa* condition for the gestational hormone profile. L_H enters $\mathcal{P}(E_1)$ with initial proban-force $\eta(L_H, \tau_1) = 0.50$, accumulating through the gestational period to:

$$\eta(L_H, t^{*-}) = 0.65$$

Effect 3 — L_I threshold crossing (Dormant activation). The immune-tolerance marker had Meas = 1 at t_0 but had not yet crossed threshold $\theta(L_I) = 0.75$. At stopping time τ_2, E_2's accumulated proban-force crosses the threshold:

$$\sum_{L'' \in e^*} \eta_{\tau_2}(L'') = 0.60 + 0.20 = 0.80 \geq \theta(L_I) = 0.75$$

L_I transitions from Dormant to *Vyakta* at τ_2. By t^{*-}: $\eta(L\_I, t^{*-}) = 0.80$. The complete *Lakṣaṇa*-force state immediately before birth:

Lakṣaṇa	$\eta(L, t^{*-})$	State at t^{*-}
L_{Fe}	0.94	*Vyakta*
L_H	0.65	*Vyakta*
L_I	0.80	*Vyakta*
L_g	0.90	*Vyakta*

10.2.3 The MIF at t* (Birth) and the Inheritance Partition

At t^* (birth), MIF$(E_2, t^*, s^*) = (\Psi, Y, T)$ fires. The Spatio-Temporal Inheritance Operator Φ partitions $\mathcal{P}(E_1)|_{t^{*-}} = \{L_{Fe}, L_H, L_I, L_g\}$ into the four disjoint subsets of Definition 5.1.

$\mathcal{P}_C$ (Continued) — $\{L_{Fe}, L_I\}$. These two *Lakṣaṇas* have causal bases rooted in E_1's own physiology. Post-birth, their proban-forces persist and evolve under E_1's own post-natal dynamics:

```
η(L_Fe, t*+) = 0.94   [continues, evolves by E₁'s dynamics]
η(L_I,  t*+) = 0.80   [continues, evolves by E₁'s dynamics]
```

$\mathcal{P}_X$ (Discontinued) — L_H. The gestational hormone profile's entire proban-force was rooted in E_2's *Avyakta* phase. Its causal basis is dissolved at t^*. By Definition 5.1(ii) and the dissolution update:

```
η(L_H, t*+1) = 0   ← unconditionally, by Ψ-cascade dissolution mode
σ(L_H, t*+)  = Extinguished
```

The proban-force of L_H does not decay toward zero asymptotically — it is set to absolute zero by the dissolution mechanism at t, and by Axiom A6 (Extinguishment Irreversibility) it cannot be reactivated. This is the empirical signature of the dissolution update: not weight decay, but structural deletion.*

$\mathcal{P}_I$ (Inherited) — L_g. The shared genetic marker set has characteristic $\chi(L_g)$ that transfers from E_1 to E_2 at t^*. A copy $\tilde{L}_g$ is created in $\mathcal{P}(E_2)$ with transfer coefficient $\rho = 0.60$:

$$\eta(\tilde{L}_g,\ t^*+1) = \rho \cdot \eta(L_g,\ t^{*-}) = 0.60 \times 0.90 = 0.54$$

The original L_g remains in $\mathcal{P}(E_1)$ with η = 0.90. E_2 receives $\tilde{L}_g$ with η = 0.54, which evolves under E_2's own post-birth causal dynamics.

$\mathcal{P}_B$ (Blueprint-Transferred). The *Kāraṇa*-domain *Lakṣaṇas* encoding E_2's developmental trajectory — immunological disposition, metabolic architecture, temperamental latencies — transfer as $\mathscr{B}(D_{E_2})$, the foundational blueprint of the new entity. These *Lakṣaṇas* carry $\vec{P} = (\emptyset, \emptyset, \pi_K)$: invisible at *Sthūla* and *Sūkṣma*, present in the *Kāraṇa* projection with η values encoding their expected manifestation windows. This is the formal content of *Saṃskāra*.

10.2.4 The Inheritance Matrix

The complete transformation of the proban-force vector $\eta_{t^{*-}} = [0.94, 0.65, 0.80, 0.90]^T$ for $\{L_{Fe}, L_H, L_I, L_g\}$ under the inheritance operator Φ.

E_1 post-birth — residual force vector:

	L_{Fe}	L_H	L_I	L_g				
L_{Fe}	[1	0	0	0]	[0.94]		[0.94]	← continued
L_H	[0	0	0	0]	[0.65]		[0.00]	← architectural deletion
L_I	[0	0	1	0]	[0.80]	=	[0.80]	← continued
L_g	[0	0	0	1]	[0.90]		[0.90]	← continued

E_2 at t*+ — inherited force vector ($\mathcal{P}_I$ component):

		L_{Fe}	L_H	L_I	L_g			
						[0.94]		
						[0.65]		
						[0.80]	=	
$\tilde{L}_g$	($\mathcal{P}_I$)	[1	0	0	0.60]	[0.90]		[0.54]

The zero in the L_H row of E_1's post-birth matrix (architectural deletion, not asymptotic decay) and the 0.60 coefficient in $\tilde{L}_g$'s transfer row (permanent structural assignment) are both operations that no standard probabilistic graphical model can represent without the four-state ontology and the dissolution edge.

10.2.5 Empirical Implementation Notes

A bioinformatician or machine learning practitioner implementing KLN inference for a domain with *Avyakta*-phase entities would encode the above procedure as follows.

Initialisation. At t_0, register E_2 as a Pure *Avyakta* node with $\eta(E_2, t_0) = 0.8$. Set $\vec{P}_{E_2} = (\emptyset, \emptyset, \pi_K(E_2))$. E_2 participates in causal hyperedges through $\mathscr{H}C$ but appears in no observation channel.

***Avyakta*-phase propagation.** At each timestep $t \in [t_0, t^*)$, propagate η updates through the Ψ-cascade using the causal transfer function f (Definition 4.1), applying the conservation constraint $\Sigma\ \alpha(e, L) \leq 1$ per hyperedge. Register any $\Lambda_{blocked}$ *Lakṣaṇas* enabled by accumulating proban-force via the Y-cascade.

MIF execution at t*. Apply g to all $L \in \mathcal{P}_X$: set η = 0 unconditionally, not through backpropagation or gradient update. Apply the transfer coefficient ρ to all $L \in \mathcal{P}_I$: create $\tilde{L} \in \mathcal{P}(E_2)$ with $\eta(\tilde{L}) = \rho \cdot \eta(L, t^{*-})$. Register $\mathcal{P}_B$ as the foundational blueprint encoding $\mathscr{B}$(D_{E₂}) for E_2's post-birth *Lakṣaṇa* trajectory.

Empirical distinction from BN/HMM. A standard model would represent the gestational hormone profile as a node with a small but positive weight post-birth, an artifact of the continuity assumptions built into conditional probability tables. The KLN representation sets $\eta(L_H, t^*+1) = 0$ by architectural deletion, yielding different posteriors for every downstream *Lakṣaṇa* whose causal path in $\mathscr{H}C$ runs through L_H's contribution — and correctly

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capturing the biological reality that gestational hormones are not merely attenuated at birth but are actively terminated by the endocrine restructuring the birth event triggers.

10.3 Quantum Illustration: The Quantum Jump and Photon Emission

This section provides a concrete numerical demonstration of the KLN formalism applied to a domain drawn from quantum optics: the resonance fluorescence of a two-level atom and the emission of a single photon via a quantum jump. The scenario is chosen because it contains a naturally occurring analog of every KLN structural element — *Avyakta* causal activity, *pramāṇa*-stratified observability, the four-way inheritance partition, and, most critically, the dissolution edge — in a setting whose physics is independently well-characterised. The notation follows Definitions 2.8, 4.1, 4.2, 4.3, and 5.1 throughout.

The three observability domains map to the following physical levels:

Domain	Physical Level	Description
Sthūla	Photodetector click	The gross, directly registered event. Empty before t*.
Sūkṣma	Population inversion $\langle\sigma_z\rangle$, dipole moment $\langle\sigma_x\rangle$	Inferrable through homodyne spectroscopy without individual photon detection.
Kāraṇa	Full quantum state $\lvert\psi(t)\rangle$	The blueprint encoding ω_0, g, Γ, polarization mode. Never directly observed; causally prior to every Sthūla and Sūkṣma manifestation.

10.3.1 Initial Configuration at t_0

Let E_1 denote a two-level atom driven continuously by a coherent laser field. Let E_2 denote the fluorescent photon the atom will eventually emit. Before emission, E_2 exists as a Pure *Avyakta Lakṣaṇa* with initial proban-force:

$$\eta(E_2, t_0) = 0.80$$

E_2's state vector at t_0 is $\vec{P}_{E_2} = (\emptyset, \emptyset, \pi_K(E_2))$: the photon is present in the *Kāraṇa* blueprint of the atom-field system but triggers no *Sthūla* or *Sūkṣma* signature yet. The atom's domain $\boldsymbol{\mathcal{P}}(E_1)$ at t_0 contains four *Lakṣaṇas*:

Lakṣaṇa	Physical Description	η(L, t₀)	State at t₀
L_e	Excited-state population weight	0.85	*Vyakta*
L_d	Dipole coherence	0.72	Dormant [$\theta(L_d)$ = 0.75]
L_ε	Zero-point field coupling energy	0.55	Pure *Avyakta*
L_{pol}	Polarization alignment	0.90	*Vyakta*

L_d (dipole coherence) is Dormant at t_0: it is Meas = 1 (its threshold is defined by the Rabi frequency, hence formally decidable), but has not yet crossed $\theta(L_d) = 0.75$. L_ε (zero-point field coupling) is Pure Avyakta: it carries positive η and acts through $\mathcal{H}$ to modify L_d's threshold dynamics, but no Pramāṇa instrument can detect it directly.

10.3.2 *Avyakta* Phase [t_0, t*) — Three MIF-Precursor Effects

During [t_0, t*), E_2 acts as a Pure *Avyakta* node with $\eta(E_2, t) > 0$. Three effects are produced through the *Vyāpinī*.

Effect 1 — L_e modification (Ψ-cascade, causal mode). The causal hyperedge (E_2, L_e) ∈ EC with *vyāpti*-transfer coefficient α = 0.20 encodes the back-action of the vacuum field on the excited-state population (Wigner–Weisskopf mechanism). By t^{*-}:

$$\eta(L_e, t^{*-}) = 0.85 - 0.20 \times 0.80 = 0.69$$

The slight reduction reflects the partial transfer of causal weight from the atomic excited state to the growing vacuum field mode — measurable indirectly through the modified excited-state lifetime, operating through *Sūkṣma* and *Kāraṇa* projections before t*.

Effect 2 — L_{st} introduction (Y-cascade, *Uddeśa* event). At stopping time τ_1, the cumulative causal weight of E_2's *Avyakta* phase satisfies the *Uddeśa* condition for the photon's Stokes polarization parameter. L_{st} enters $\mathcal{P}(E_1)$ with initial proban-force:

$\eta(L_{st}, \tau_1) = 0.45 \quad \rightarrow \quad \eta(L_{st}, t^{*-}) = 0.45$

Effect 3 — L_d threshold crossing (Dormant activation). At stopping time τ_2, the combined proban-force of E_2 and the driving field across hyperedge e* crosses the Dormant activation threshold:

$$\sum_{L'' \in e^*} \eta_{\tau_2}(L'') = 0.55 + 0.23 = 0.78 \geq \theta(L_d) = 0.75$$

L_d transitions from Dormant to *Vyakta* at τ_2. By t^{*-}: $\eta(L_d, t^{*-}) = 0.78$. The complete *Lakṣaṇa*-force state immediately before the quantum jump:

Lakṣaṇa	$\eta(L, t^{*-})$	State at t^{*-}
L_e	0.69	*Vyakta*
L_d	0.78	*Vyakta*
L_ε	0.55	Pure *Avyakta*
L_{pol}	0.90	*Vyakta*
L_{st}	0.45	*Vyakta* (registered at τ_1)

10.3.3 The MIF at t* (Quantum Jump) and the Inheritance Partition

At t* (photodetector click), MIF(E_2, t*, s*) = (Ψ, Y, T) fires. The Spatio-Temporal Inheritance Operator Φ partitions $\mathcal{P}(E_1)|\_\{t^{*-}\} = \{L_e, L_d, L_\varepsilon, L_{pol}, L_{st}\}$.

$\mathcal{P}_X$ (Discontinued) — L_e, L_d. At the quantum jump, the atom unconditionally transitions to its ground state. By Definition 5.1(ii) and the dissolution update g (Definition 4.2):

```
η(Lₑ, t*+1) = 0   ← unconditionally, quantum jump resets excited state
η(L_d, t*+1) = 0   ← dipole coherence collapses to zero at the jump
σ(Lₑ, t*+) = Extinguished
σ(L_d, t*+) = Extinguished
```

The quantum jump (Monte Carlo wavefunction treatment) sets the excited-state amplitude to exact zero — not by Bayesian update, not by exponential decay, but by projection: $\psi \rightarrow \sigma_\psi/|\sigma_\psi|$. This is the dissolution edge. No CPT entry $P(L_e = active \mid click) = \varepsilon$: the causal force is architecturally deleted.

$\mathcal{P}_C$ (Continued) — L_ε. The zero-point field coupling *Lakṣaṇa* persists in E_1 after t*: the atom retains its coupling to the vacuum field in the ground state.

```
η(L_ε, t*+) = 0.55   [continues by E₁'s ground-state dynamics]
```

$\mathcal{P}_I$ (Inherited) — L_{pol}. The polarization alignment *Lakṣaṇa* transfers structurally from E_1 to E_2 at t* with transfer coefficient ρ = 0.65 (encoding partial decoherence from finite collection aperture):

$\eta(\tilde{L}_{pol}, t^*+1) = \rho \cdot \eta(L_{pol}, t^{*-}) = 0.65 \times 0.90 = 0.585$

The original L_{pol} remains in $\mathcal{P}(E_1)$ with η = 0.90. The photon E_2 receives $\tilde{L}_{pol} \in \mathcal{P}_I$ with η = 0.585, evolving under E_2's own post-detection dynamics.

$\mathcal{P}_B$ (Blueprint-Transferred). The *Kāraṇa*-domain *Lakṣaṇas* encoding the photon's physical character — its transition frequency ω_0, temporal wavepacket shape, transverse mode structure, and L_{st} — transfer as $\mathscr{B}(D_{E_2})$. These carry $\vec{P} = (\emptyset, \emptyset, \pi_K)$: invisible at *Sthūla* and *Sūkṣma*, present in the *Kāraṇa* projection with η values encoding expected measurement outcomes. This is the spectral blueprint — ω_0 and Γ determine every subsequent *Sthūla* measurement the photon will yield, yet they are properties of the atomic structure transmitted through the emission process, not properties observable during the *Avyakta* phase.

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10.3.4 The Inheritance Matrix

The complete transformation of the proban-force vector ηt^{*-} = [0.69, 0.78, 0.55, 0.90, 0.45]^T for {L_e, L_d, L_ε, L_{pol}, L_{st}} under the inheritance operator Φ.

E_1 post-jump — residual force vector:

	L_e	L_d	L_ε	L_{pol}	L_{st}				
L_e	[0	0	0	0	0]	[0.69]		[0.00]	← dissolution
L_d	[0	0	0	0	0]	[0.78]		[0.00]	← dissolution
L_ε	[0	0	1	0	0]	[0.55]	=	[0.55]	← continued
L_{pol}	[0	0	0	1	0]	[0.90]		[0.90]	← continued
L_{st}	[0	0	0	0	0]	[0.45]		[0.00]	← to $\mathcal{P}_B$

E_2 at t*+ — inherited force vector:

		L_e	L_d	L_ε	L_{pol}	L_{st}			
							[0.69]		
							[0.78]		
							[0.55]	=	
$\tilde{L}_{pol}$	($\mathcal{P}_I$)	[0	0	0	0.65	0]	[0.90]		[0.585]
$\tilde{L}_{st}$	($\mathcal{P}_B$)	[0	0	0	0	1]	[0.45]		[0.450]

The L_e and L_d rows of E_1's post-jump matrix are zero by dissolution — not by decay. In the Lindblad master equation, $\rho_e e(t) = \rho_e e(0)\exp(-\Gamma t)$ is always positive for any finite t. The quantum jump and the KLN dissolution update both set the force to exact zero at t. A standard model built on CPTs can only approximate this as an asymptotic limit. Proposition 9.1 proves it cannot do otherwise.*

10.3.5 The Tunneling Operator and Entanglement

The *Parīkṣā*-node in this scenario is the polarising beam splitter downstream of the photodetector: the bifurcation node at which the photon's path is committed to the horizontal or vertical channel and at which π_t is revised by the Tunneling operator T. The inherited *Lakṣaṇa* $\tilde{L}_{pol}$ with η = 0.585 enters the basis of this *Parīkṣā*-node at t*, and the Tunneling revision applies: $\pi_{t^*+1}(\varphi) \propto \pi_{t^*-}(\varphi) \cdot w(\tilde{L}_{pol}, t^* + 1)$

If a second entangled photon exists in the network — as in a Bell-state experiment where E_2 is one member of an entangled pair — the revision of π at E_2's *Parīkṣā*-node simultaneously updates the path distribution at the corresponding node for E_2's partner through the *Vyāpinī*. This nonlocal correlation is native to the KLN formalism: entanglement is the quantum instance of *vyāpti* — invariable concomitance across spatially separated nodes — implemented through causal hyperedges that carry no signal but enforce correlated outcomes at *Sthūla* measurement events.

10.3.6 Empirical Distinction from Standard Quantum Master Equations

A quantum information researcher implementing KLN inference for a photon-emission domain would find three predictions that differ from the standard Lindblad master equation (LME) treatment.

Quantity	LME prediction	KLN prediction	Physical basis
Excited-state population at t*	$\rho_e e(t) \to 0$ asymptotically; always positive for finite t	$\eta(L_e)$ = 0 exactly at t*; $\sigma(L_e)$ = Extinguished	Quantum jump is a projection, not a limit
Dipole coherence post-jump	$\rho_e g(t)$ decays at rate $\Gamma/2 + \gamma_\varphi$; positive for all finite t	$\eta(L_d$, t*+1) = 0 exactly; structural collapse at the jump	Wavefunction reset at detection event
Polarization inheritance	Encoded globally in input-output formalism; no per-*Lakṣaṇa* coefficient	ρ = 0.65 explicit transfer coefficient; $\eta(\tilde{L}_{pol})$ = 0.585 at t*+	Collection aperture efficiency as architectural parameter

The Dissolution Expressiveness Gap (Proposition 9.1) is, from the quantum optical perspective, the formal proof that no master equation built on conditional probability tables — however fine the timestep, however many the Lindblad operators — can represent the quantum jump as a structural primitive rather than an asymptotic limit. Both illustrations use identical KLN operators — the Spatio-Temporal Inheritance Operator Φ (Definition 5.1), the dissolution update g (Definition 4.2), and the MIF cascade (Definition 4.3) — applied to physically distinct domains. The structural identity of the inheritance partition, the matrix form of the transformation, and the unconditional zeroing of discontinued Lakṣaṇas confirm that the formalism is genuinely domain-independent.

11. FUTURE DIRECTIONS

The formal architecture established in this paper opens several lines of inquiry whose resolution requires independent treatment. Five directions are identified here in order of theoretical proximity to the present framework.

11.1 The *Sākṣī*-State: A Sixth Epistemic Regime

(Forward citation: Ketharaju, R. B. (2026). *The Sākṣī Dimension: Witnessing, Videha Ontology, and the Extended Kṣetra-Kāla Framework*. Manuscript in preparation [P4].)

The five-state epistemic taxonomy of the current framework — *Vyakta* (manifested and measurable), Pure *Avyakta* (unmanifested and unobservable), Observable-*Avyakta* (detected but unmeasured), Dormant (measurable but threshold-pending), and Extinguished — does not yet accommodate a condition that the *Nyāya* and *Vedānta* traditions jointly recognise as irreducibly distinct from all five: the state of bare witnessing (*Sākṣībhāva*), in which a *Lakṣaṇa* is present to consciousness without passing through any *Pramāṇa* instrument and without leaving any trace in the measurability indicator Meas.

The formal signature of this sixth regime is: $\kappa = \text{open} \wedge \eta > 0 \wedge \text{Obs\_}Sth\bar{u}la = \text{Obs\_}S\bar{u}k\d{s}ma = 0 \wedge \text{Meas} = 0 \wedge (\omega = 1)$, where ω is a primitive not derivable from any component of the *Lakṣaṇa* quintuple as currently defined. In quantum mechanical correspondence, this maps to the class of events that carry nonzero amplitude in the *Kāraṇa* domain and are experientially present to an observer, yet produce no record in any classical or quantum instrument — the collapse event as undergone from within, rather than as registered from without.

The present paper formalises this extension through the product decomposition $\sigma(L, t, s) = (\sigma\_P, \omega)$ and the extended reconciliation operator ⊗ (Definition 9.1), which together produce the five-element displayed state space 𝔭 = {*Vyakta*, Dormant, *Avyakta*, Extinguished, Witnessed-*Vyakta*}. The *Sākṣī* indicator $\omega \in \{0,1\}$ is determined independently from $\mathscr{F}$_int, with $\mathscr{F}$_int ⊥ $\mathscr{F}$ by Lemma 2.1. The complete dynamic theory of ω — including its interaction with the dissolution edge, the *Yama* Registry, and the three independent proof paths of the *Nyāya* Liberation Theorem — is developed in P4.

11.1.1 The observer boundary as intentional design.

The ontological boundary between the five *Pramāṇa*-mediated states of the current framework and the *Sākṣī* regime is an intentional architectural parameter, not an oversight. An analogy from physics makes the structural position of this boundary precise. In quantum mechanics, the collapse of a wavefunction appears categorically different depending on whether it is registered from outside the system — as a stochastic reduction recorded by a measuring apparatus, an event that leaves a *Pramāṇa*-accessible trace in an instrument — or undergone from within, as an immediate, non-inferential shift in the system's own state that produces no external record. The external observer applies the Born rule and registers a measurement outcome through a formal operator; the internal witness undergoes a change that is epistemically direct and leaves no trace in any observable. Axiom A1, as bounded by its scope caveat, governs the former class of events. The *Sākṣī* state belongs to the latter class, and its treatment requires that ω be ontologically primitive in precisely the way that the internal experience of wavefunction collapse is not derivable from any quantity available to the external measuring apparatus. The scope

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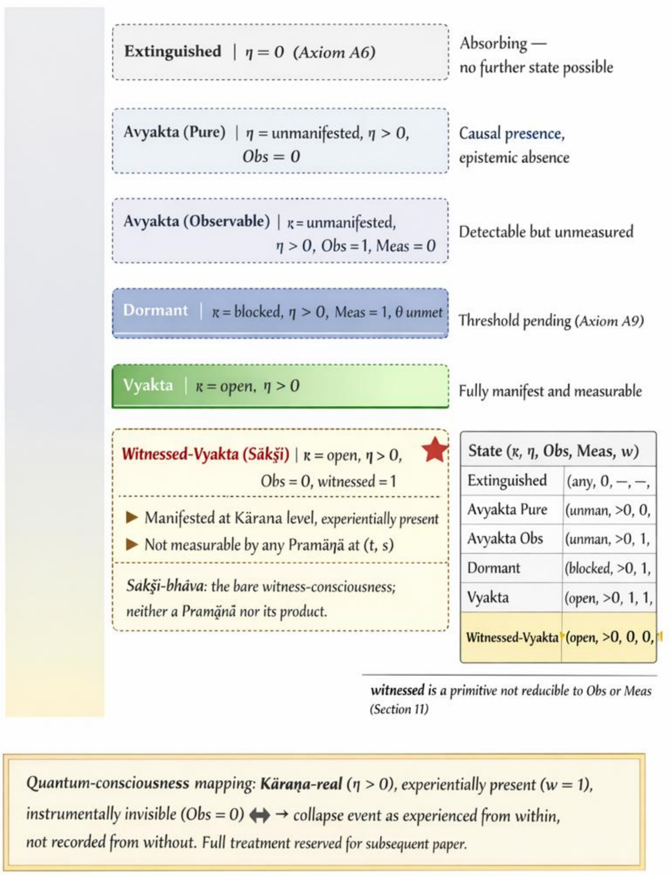
caveat of Axiom A1 is therefore not a limitation acknowledged defensively but a self-aware acknowledgment that the boundary between *Pramāṇa*-mediated and unmediated knowledge is a structural feature of the epistemic architecture.

FIGURE 11 — **The Six Epistemic Regimes:** Toward *Witnessed-Vyakta (Sākṣī)* **States**



A complete treatment of Witnessed-Vyakta states, developed in P4, requires:

- extending the Lakṣaṇa quintuple to a sextuple by adjunction of ω as a primitive witnessing indicator;
- defining a Sākṣī-MIF whose cascade structure may differ from the standard triple (Ψ, Y, T) in that the Y-component registers Lakṣaṇas enabled by witnessing rather than by Pramāṇa-verified manifestation;
- proving or refuting whether Theorem 8.7 (Non-Contradiction of Simultaneous Domain States) extends to configurations in which a Lakṣaṇa is simultaneously Extinguished in the Sthūla domain and Witnessed-Vyakta in the Sākṣī domain — the Sākṣī-Videha configuration ($\eta = 0$, $\omega = 1$) first identified in the present paper's state labelling convention;
- investigating whether the dual-proof structure of the Nyāya Liberation Theorem (Theorem 10.2) admits a third independent proof path via the Sākṣī-state — through ω rather than through the Inheritance Operator or Dissolution Cascade alone.

11.2 The *Bheda* Algebra: Replacing the *Vividhākāra* Algebra

(Forward citation: Ketharaju, R. B. (2026). *Kṣetra-Kāla Bheda and the Algebraic Foundations of KLN_S: The Bheda Algebra, Dual Prārabdha, and the Videha Ontological Spectrum*. Manuscript in preparation [P2].)

The current paper employs the *Vividhākāra* algebra $\mathbb{V} = \mathbb{R}_+^3$ as a holding structure for the three-component force representation ($\eta\_Sth\bar{u}la$, $\eta\_S\bar{u}k\d{s}ma$, $\eta\_K\bar{a}ra\d{n}a$). Under the Universal *Kāraṇa* Condition, this algebra undergoes structural simplification: the *Kāraṇa* component collapses to a one-dimensional ray $\mathbb{R}_+$ scaled by the root *Lakṣaṇa* force, and the reconciliation operator reduces to $\otimes(n) = \rho\_n \cdot \eta\_K\text{^}root \cdot f(r\_n, u\_n)$. This description is adequate for the present paper's purposes but understates the algebraic structure required by the quantum extension (Section 11.9) and by the multi-field dynamics of the full *Videha* spectrum. P2 will replace $\mathbb{V} = \mathbb{R}_+^3$ with the formally defined **Bheda Algebra**:

$$\mathbb{A}\_KLN = \mathbb{R}\_\acute{S}K \oplus \mathbb{C}\_Bh\bar{u}ta \oplus \mathbb{R}\_S\bar{a}k\d{s}\bar{\imath} \oplus \mathcal{A}\_K\bar{a}la$$

Each component carries its own imaginary structure determined by its *Kṣetra-Kāla Bheda*: $\mathbb{C}\_Bh\bar{u}ta$ for the *Bhūta-Ākāśa* field, where $[\mathcal{K}, \mathcal{T}] = i\hbar$; $\mathbb{R}\_\acute{S}K$ for *Śukla-Kṛṣṇa* dynamics, where $[\mathcal{K}, \mathcal{T}] = 0$; $\mathbb{R}\_S\bar{a}k\d{s}\bar{\imath}$ carrying $\omega \in \{0,1\}$ as a two-point subspace orthogonal to all *Pramāṇa* subalgebras by Lemma 2.1; and $\mathcal{A}\_K\bar{a}la$ recording the running *Avyakta* debt. The total causal intensity norm is:

$$\eta\_total = |\eta\_\acute{S} - \eta\_K|^2 + |\psi\_Bh\bar{u}ta|^2 + \omega^2 + \Sigma\_a\, |\mathcal{T}\_a|^2$$

11.3 Rigorous Martingale Theory for the Latent Force Process

(Developed as an internal section within P2: Ketharaju, R. B. (2026). *Kṣetra-Kāla Bheda and the Algebraic Foundations of KLN_S*.)

Lemma 8.1 of the present paper asserts that the total latent force process $F_t = \Sigma_{L \in P_t} \eta(L, t)$ is a supermartingale with respect to the filtration $\{\mathscr{F}_t\}$. The current proof sketch exploits Axiom A5 (force non-increase on extinguishment) and Axiom A4 (threshold monotonicity), but does not establish the integrability condition $E[F_t] < \infty$ in the case where $|P_t| \to \infty$ under iterated Y-cascade events. Under the Universal Kāraṇa Condition, domain growth is unbounded (Theorem 6.1), and the sum F_t may therefore fail to be integrable in the classical Doob–Meyer sense unless the proban-force inheritance coefficients $\rho_n \in (0, 1]$ are summable along the causal tree.

A rigorous treatment, to be provided in the relevant section of P2, requires:

- an explicit integrability condition on the blueprint-transfer coefficients ρ_n under UKC;
- proof or counterexample for the supermartingale convergence theorem (Doob 1953, Theorem 4.1) applied to F_t when $|P_t|$ grows without bound;
- characterisation of the almost-sure limit $F_\infty = \lim_{t \to t^*} F_t$ in the *Nyāya* Liberation case, where Theorem 10.3 asserts that this limit equals the *Avyakta* Debt $D_{Av}(t^*)$ rather than zero.

The martingale theory is foundationally important because Lemma 8.1 is invoked in the proof of the MIF Monotone Extinguishment Bound (Theorem 8.5) and indirectly in the information budget identity of Theorem 10.3. The *Sākṣī* extension additionally requires a joint treatment of the *Pramāṇa* and *Sākṣī* force processes as a two-filtration system, since the process ω(t) is not adapted to $\{\mathscr{F}_t\}$ and the extended norm η_{total} of the *Bheda* Algebra therefore falls outside the classical supermartingale framework.

11.4 κ-Dynamics and Phase Transitions in the *Kāraṇa* Index

(Developed as an internal section within P2: Ketharaju, R. B. (2026). *Kṣetra-Kāla Bheda and the Algebraic Foundations of KLN_S*.)

The *Kāraṇa* Index $\kappa(t) = |P_t \nsim_K|$ is currently governed by two results: Axiom A8 (non-increasing under Y-cascades) and Theorem 6.1 (constant at unity throughout the UKC epoch). What remains uncharacterised is the full dynamics of κ in the non-UKC regime where $\kappa > 1$ and external *Uddeśa* events introduce independent blueprint roots.

Of particular interest is whether κ(t) can decrease discontinuously — a *κ-phase transition* — when two previously independent *Dravya* are shown to share a common blueprint root upon the manifestation of a connecting *Lakṣaṇa*. If such transitions are possible, they constitute a formal analogue of the classical Indian doctrine of *sāmānya* (universal): the discovery of a shared characteristic across previously unrelated substances that retroactively unifies their causal grounds. The conditions under which such transitions are triggered, and the effect of a κ-phase transition on the MIF cascade that accompanies it — particularly the Y-component, which may now register a class of *Lakṣaṇas* blocked by the prior multi-root partition — require a systematic treatment that goes beyond the scope of Axiom A8 as currently stated.

This direction also connects to the underspecification of Axiom A6 (Blueprint Persistence) identified in the peer review of this manuscript: a fully specified dynamical theory of κ would resolve whether Blueprint Persistence is better formulated as a monotone constraint on the blueprint encoding function or as a conservation law on the causal quotient structure. Since ω is determined from $\mathscr{F}_{int}$ independently of κ, the conditions under which κ-phase transitions and ω-transitions co-occur — or fail to — bear on the stability of the Witnessed-*Vyakta* state across blueprint-unification events, and will be treated in the κ-dynamics section of P2.

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11.5 The *Videha* Ontological Spectrum and the *Videha* Principle

(Forward citation: Ketharaju, R. B. (2026). *Kṣetra-Kāla Bheda and the Algebraic Foundations of KLN_S: The Bheda Algebra, Dual Prārabdha, and the Videha Ontological Spectrum*. Manuscript in preparation [P2].)

The five-state space ꝑ introduced in this paper is derived from the formal machinery (η, κ, ω, ⊗) without an explicit statement of the ontological commitment that motivates its structure. P2 will open with a dedicated foundational section establishing the ***Videha*** **Principle** and the full ontological spectrum before any formal machinery is introduced.

That foundational section will establish three components:

- **The three-*Śarīra* doctrine** (*Sthūla*, *Sūkṣma*, *Kāraṇa Śarīra*) as the formal precursor to the five-state space: the three body-layers supply the three *Pramāṇa* components of σ_P before the *Sākṣī* dimension ω is adjoined.
- **The six-type *Videha* hierarchy** mapped to KLN*S* states, from Type 1 (*Sthūla*-embodied, fully *Vyakta*) through Type 5 (*Sākṣī-Videha*, η = 0, ω = 1) to Type 6 (complete dissolution, Extinguished with ω = 0).
- **The *Videha* Principle as a formal proposition**: causal reality (η > 0 or ω = 1) is independent of and not reducible to observational detectability. Formally:

∄ measurable Φ: (Obs_Sthūla, Obs_Sūkṣma, Meas) → {0,1}
such that η(L,t) > 0 ↔ Φ = 1 for all L ∈ 𝓟, (t,s) ∈ 𝕋 × 𝓢

This proposition is provable from the construction of (Ω_joint, 𝓕_joint) with 𝓕 ⊥ 𝓕_int and the non-derivability Lemma 8.4* of the present paper. Its full three-independence form — unifying the *Videha*, Dissolution, and *Sākṣī-Videha* axes — is the subject of Section 11.8.

11.6 Formal *Pramāṇa* Operators and the Measurement Problem

(Developed as an internal section within P3: Ketharaju, R. B. (2026). *Quantum Mechanics as a Restriction of KLN_S: The Three-Restriction Theorem and the Expressiveness Hierarchy*. Manuscript in preparation [P3].)

The four classical *Nyāya* instruments of valid knowledge — *Pratyakṣa* (perception), *Anumāna* (inference), *Upamāna* (analogy), and *Śabda* (testimony) — currently enter the KLN framework only through the observability indicators Obs_*Sthūla* and Obs_*Sūkṣma*. Each *Pramāṇa* accesses a different projection domain: *Pratyakṣa* grounds π_V, *Anumāna* and *Upamāna* ground π_A, and *Śabda* has no current formal representation, as it encodes transmitted knowledge that may revise the blueprint B(D) without producing direct observational evidence.

A rigorous formalisation of *Pramāṇa* operators would require defining, for each instrument μ ∈ {*Pratyakṣa*, *Anumāna*, *Upamāna*, *Śabda*}, a measurable map Π_μ: 𝓟 × (𝕋 × 𝓢) → {0,1} such that Obs_*Sthūla*(L,t,s) = Π_*Pratyakṣa*(L,t,s) and Obs_*Sūkṣma*(L,t,s) = max(Π_*Anumāna*, Π_*Upamāna*)(L,t,s). The role of Π_*Śabda* as a blueprint-revision operator would require extension of the MIF cascade to a four-component tuple (Ψ, Υ, Τ, Σ) where Σ encodes testimonial revision of the *Kāraṇa*-level blueprint, providing a formal treatment of the *āgama* (scriptural) mode of knowledge whose structural position in the network has not previously admitted rigorous formulation. Because the quantum restriction R2 (Observability restriction: Meas = 1, ω = 0) is defined precisely in terms of the *Pramāṇa* access profile, the complete formalisation of *Pramāṇa* operators is a prerequisite for the proof of the Three-Restriction Theorem, and is accordingly treated as an internal section of P3.

11.7 Dual *Prārabdha*, the *Yama* Registry, and the Dissolution Edge

(Forward citation: Ketharaju, R. B. (2026). *Kṣetra-Kāla Bheda and the Algebraic Foundations of KLN_S: The Bheda Algebra, Dual Prārabdha, and the Videha Ontological Spectrum*. Manuscript in preparation [P2].)

Proposition 9.1 of the current paper establishes the expressiveness gap between KLN*S* and classical probabilistic networks on three axes. The dissolution condition g(η) = 0 (Axis II) and the *Avyakta* debt accumulation D_Av

(Axis III) are stated as gap-witnesses without the full dynamic structure that governs them. P2 will develop the **Dual *Prārabdha*** framework that supplies this structure. The *Prārabdha* partition at time t is:

$\mathcal{K}(t) = \mathcal{K}\_Ś(t) \sqcup \mathcal{K}\_K(t) \sqcup \mathcal{K}\_0(t)$

with *Śukla* coherence coefficient c_Ś = I_c · J_c · K_c (*Icchā* purity × *Jñāna* excellence × *Kriyā* excellence), *Kṛṣṇa* coherence coefficient c_K = c_{*mithyā*} · c_{*doṣa*} · c_{*pravṛtti*} · c_{*janma*}, and the ***Lajjā-Poka-Yoke* operator** Λ introducing asymmetric amplification:

$\theta\_\Lambda(K\_error) = \theta(K) \cdot exp(+\Lambda\_K), \quad \theta\_\Lambda(K\_Dharma) = \theta(K) \cdot exp(-\Lambda\_Ś)$

These definitions support Theorem 10.4* (opposing force structure), to be fully proved in P2:

$I\_SK(L, t) = \eta\_Ś \cdot exp(+\Lambda\_Ś) - \eta\_K \cdot exp(-\Lambda\_K)$

$D\_Av\^{complete} = D\_Av\_Ś - P(t^*) + D\_Av\_K + D\_Av\_\omega$

The dissolution edge — the boundary $\eta \to 0^+$ — has a quantum analogue in which the *Kāraṇa* superposition persists below the *Pramāṇa* threshold while ω may remain 1: the *Sākṣī-Videha* state (Type 5). Its formal characterisation requires the ***Yama* Registry** as a *Viśva-Sākṣī* — a universal witnessing operator that records dissolution events across all *Lakṣaṇas*, providing the global consistency condition that prevents ω from being recycled after Type 5 dissolution. The *Yama* Registry is defined in P2 and its consistency with $\mathscr{F}$_int ⊥ $\mathscr{F}$ is established there.

11.8 Proposition 9.1 Elevated: The Four-Axis Expressiveness Theorem

(Forward citation: Ketharaju, R. B. (2026). *The Sākṣī Dimension: Witnessing, Videha Ontology, and the Extended Kṣetra-Kāla Framework*. Manuscript in preparation [P4].)

Proposition 9.1 of the current paper asserts the three-axis gap KLN ⊋ $\mathcal{N}$ with abbreviated witnesses. P4 will elevate this to a fully proved theorem and extend it to a four-axis result separating KLN*S*, KLN, and $\mathcal{N}$ by independent constructions, with detailed proofs.

The three-axis result (KLN ⊋ $\mathcal{N}$) will be established via three formal lemmas:

- **Lemma 9.1 (*Videha* Axis):** CPT networks cannot represent constitutive *Sthūla*-absence with positive causal weight. Witness L_*Videha*: η > 0 ∧ Obs_*Sthūla* = 0 simultaneously, for which no node V ∈ V(N) carries positive probability mass.
- **Lemma 9.2 (Dissolution Axis):** CPT networks cannot implement g(η) = 0 unconditionally and permanently while preserving the causal structure of child *Lakṣaṇas*. Witness L_Dissolve exhibits permanent dissolution with active children, forbidden by any CPT Markov blanket.
- **Lemma 9.3 (*Avyakta* Debt Axis):** CPT networks cannot represent dynamic domain registration, time-indexed proban-forces, or running entropy accumulation D_Av. Witness L_Debt with monotonically increasing D_Av requires a countably infinite state space in any faithful CPT representation.

Formal statement: ∄ N ∈ $\mathcal{N}$, ∄ f: $\boldsymbol{\mathcal{P}}$_KLN → V(N) faithful on all three of (Axis I) η > 0 ∧ Obs = 0; (Axis II) g(η) = 0 permanent; (Axis III) D_Av running sum.

The four-axis extension (KLN*S* ⊋ KLN ⊋ $\mathcal{N}$) adds:

- **Lemma 9.4 (*Sākṣī-Videha* Axis, KLN*S* vs. KLN):** standard KLN cannot represent the *Sākṣī-Videha* state. Non-derivability Lemma 8.4* of the present paper implies that no KLN node can encode (η = 0, ω = 1) without a structurally new dimension.
- **Lemma 9.5 (*Sākṣī-Videha* Axis, KLN vs. $\mathcal{N}$):** CPT networks cannot represent the *Sākṣī* domain. Since ω ∈ $\mathscr{F}$_int and $\mathscr{F}$_int ⊥ $\mathscr{F}$, the mutual information I(ω; V) = 0 for all V ∈ V(N).

The extended gap measure is d(KLN_S, $\mathcal{N}$) ≥ 4, with axes: (I) *Videha*, (II) Dissolution, (III) *Avyakta* Debt, (IV) *Sākṣī-Videha* (η = 0, ω = 1). Additionally, the *Videha* Principle (Section 11.5) is elevated in P4 to a unified independence proposition:

Proposition (*Videha* Principle): For any L ∈ $\mathcal{P}$ and (t, s) ∈ $\mathbb{T} \times \mathcal{S}$, the three properties (i) η(L,t) > 0; (ii) Obs_*Sthūla*(L,t,s) = 1; (iii) ω(L,t,s) = 1 are logically independent. Any two can hold without the third, and each combination corresponds to a distinct ontological category in the *Videha* taxonomy. Proof follows from $\mathscr{F} \perp \mathscr{F}$_int and Lemma 8.4* of the present paper.

11.9 Quantum Mechanics as a Restriction of KLN_S

(Forward citation: Ketharaju, R. B. (2026). *Quantum Mechanics as a Restriction of KLN_S: The Three-Restriction Theorem and the Expressiveness Hierarchy*. Manuscript in preparation [P3].)

The expressiveness hierarchy KLN_S ⊋ KLN ⊋ $\mathcal{N}$ established in this paper locates standard probabilistic models strictly below KLN*S*. A separate and equally significant containment result — that standard quantum mechanics over $\mathbb{C}$ sits strictly inside KLN*S* — is the paper's largest unstated consequence. P3 will state and prove this as the **Three-Restriction Theorem**.

The theorem establishes that KLN*S* restricts to standard quantum mechanics by applying simultaneously: (R1) **Field restriction** — confine to $\mathbb{C}$_*Bhūta* ⊂ $\mathbb{A}$_KLN, imposing $[\mathcal{K}, \mathcal{T}] = i\hbar$; (R2) **Observability restriction** — set Meas = 1 and ω = 0; (R3) ***Prārabdha* restriction** — set c_Ś = 1 and η_K = 0. Under R1–R3:

KLN_S structure	**Quantum counterpart under R1–R3**
Kāraṇa superposition	Quantum superposition $|\psi\rangle$
Śukla-Kṛṣṇa interference	Quantum interference $|A_1 + A_2|^2$
Kṣetra-Kāla Bheda ($\mathbb{C}$_*Bhūta*)	Canonical commutation $[x, p] = i\hbar$
MIF (multi-instantiation factor)	CPTP channel
Dissolution operator g	Quantum erasure
Avyakta debt D_Av	von Neumann entropy S(ρ)

*KLN_S |_{R1, R2, R3} ≅ QM_*$\mathbb{C}$
KLN_S ⊋ KLN ⊋ QM ⊋ HMM ⊋ BN

The separation QM ⊋ HMM is the standard quantum-over-classical result; the separations KLN ⊋ QM and KLN_S ⊋ KLN are the novel contributions of P3. The *Sākṣī* dimension — annihilated by R2 — supplies the final separation that no quantum formalism can recover: the state (η = 0, ω = 1) has no quantum counterpart, as quantum mechanics has no primitive witnessing indicator orthogonal to its measurement algebra.

11.10 Computation, Learning, and Empirical Application

(Developed as internal sections within P2, P3, and P4 as the relevant inference and algebraic machinery becomes available in each companion paper.)

The current paper establishes KLN*S* as a mathematical framework with formally verified properties. The next stage of development requires:

- an inference algorithm for computing the posterior state vector $\vec{\sigma}$(D,t,s) and path probability π_t(φ) from partial observations, analogous to the forward-backward algorithm for HMMs, extended to incorporate the *Sākṣī* indicator ω — whose marginal distribution may be estimable from the pattern of Witnessed-*Vyakta* transitions even though ω is not directly observable from $\mathscr{F}$;
- a parameter learning procedure for estimating the proban-force weights η, threshold functions θ, transfer coefficients ρ, and the *Śukla-Kṛṣṇa* coherence parameters (c_Ś, c_K) from empirical data;
- empirical domains in which the six-state ontology — extended from the original four by the *Sākṣī* dimension and the Dual *Prārabdha* structure — yields predictions qualitatively different from BN, HMM, or quantum probabilistic models.

The dissolution expressiveness gap (Proposition 9.1) guarantees that KLN*S* is not a re-parameterisation of existing frameworks. Candidate application domains include: developmental biology (where the four-state ontology maps directly onto gene-regulatory networks with latent causal states prior to transcription); longitudinal medical cohort studies (where Dormant conditions become *Vyakta* at clinically observable thresholds); multi-agent epistemic systems (where distinct agents hold different *Pramāṇa* access profiles to the same underlying *Kāraṇa* structure); and contemplative or phenomenological research contexts (where the *Sākṣī* dimension captures witnessing events that leave no *Pramāṇa* trace but are reported as experientially determinate). The mother-child inheritance example of Section 5 provides the template for this class of application: entities in a domain that undergo *Avyakta* phases of active causal influence prior to manifest existence are precisely the situations where standard BN and HMM models produce systematically incorrect posteriors, and where the KLN multi-domain projection operators provide the formal correction.

12. CONCLUSION

Kāraṇa-Lakṣaṇa Networks constitute a formally grounded mathematical framework for probabilistic inference whose central claim is that observability is not a single binary indicator but a three-level, domain-partitioned epistemic structure. This claim, drawn directly from the *Nyāya*, *Sāṃkhya*, and *Advaita Vedānta* traditions, has been given rigorous mathematical content through the nine axioms, thirty-two definitions, twenty-four theorems, three lemmas, three corollaries, and one proposition of this paper.

The five dimensions of the KLN ontology — *Avyakta*, *Vyakta*, *Vividhākāra*, *Vyāpinī*, and *Dravya-jñāna-kriyātmikā* — are not philosophical adornments to a pre-existing mathematical structure. They are the structural principles from which the definitions directly arise. The *Lakṣaṇa* quintuple $(\chi, \kappa, \eta, \mathcal{B}_L, \vec{P}_L)$ encodes an ontological characteristic, an accessibility state, a proban-force, a blueprint encoding, and a three-domain projection triple simultaneously — a representation with no counterpart in any existing formalism, and whose necessity is established by the structural limitations of binary networks identified in Section 1.2.

The *Vyāpinī* hypergraph $\mathcal{H} = (\mathcal{P}, E)$ partitioned into causal and dissolution edges E_C and E_D introduces a primitive — active causal destruction — whose irreducibility is established by Proposition 9.1 (the Dissolution Expressiveness Gap). The proof that no standard Bayesian network, Hidden Markov Model, or dynamic Bayesian network can represent E_D operates on three independent axes: unconditional annihilation against conditional probability, continuous proban-force zeroing against discrete inhibition, and absorbing-state permanence against reversible edge deactivation. The dissolution gap is not a quantitative gap — it is categorical. It separates KLN from the entire class of standard probabilistic graphical models by a structural primitive, not by a re-parameterisation.

The Manifestation Information Flow cascade $MIF(L^*, t^*, s^*) = (\Psi, \Upsilon, T)$ formalises the three simultaneous effects of a *Lakṣaṇa's* transition from *Avyakta* to *Vyakta*: revision of proban-force weights across the *Vyāpinī* (Ψ), registration of newly enabled *Lakṣaṇas* from $\Lambda_{blocked}$ (Υ), and path-probability revision at *Parīkṣā* nodes (T). The well-definedness of the cascade — its termination in at most $|\mathcal{P}|^2$ steps (Theorem 8.5), its measurability as a stopping time (Theorem 8.1), its monotone force decrease (Lemma 8.1) — establishes that the MIF is a computationally tractable, probabilistically valid operator and not merely a formal schema.

The Universal *Kāraṇa* Condition (UKC), the regime $|\mathcal{P} \nsim_K| = 1$ in which $|\mathcal{P}|$ grows without bound while the *Kāraṇa* Index remains exactly one, is the paper's central conceptual contribution. Theorem 6.1 — the Duality of Expansion and Collapse — establishes that these two processes are simultaneously true and operate on orthogonal algebraic levels of the same network: the cardinality level and the *Kāraṇa* quotient level respectively. The Collapse Operator $\Gamma: \mathcal{P} \to L_{root}$ is a surjective lattice homomorphism that preserves total proban-force, blueprint encoding, and causal ordering while forgetting domain distinctions, state distinctions, and *Vividhākāra* graded structure — the formal correlate of the *Advaita Vedānta* doctrine of *vivartavāda*: apparent multiplicity arising on a single, unchanging causal ground (Shankara, Brahmasūtrabhāṣya 2.1.14).

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The Spatio-Temporal Inheritance Operator Φpartitions the *Lakṣaṇa* domain of a source entity at the moment of a child entity's manifestation into four disjoint subsets: Continued $\mathcal{P}_C$, Discontinued $\mathcal{P}_X$, Inherited $\mathcal{P}_I$, and Blueprint-Transferred $\mathcal{P}_B$. The uniqueness of this partition (Theorem 8.10) and its force conservation property (Theorem 8.9) establish that Φ is a well-defined mathematical operator. Its philosophical content — encoding the *Sāṃkhya* understanding of *Saṃskāra* as deep causal impression transferred at the moment of a new entity's manifestation — is precisely what required the four-state ontology to formalise: the distinction between what is manifest-transferred ($\mathcal{P}_I$) and what is blueprint-transferred in *Avyakta* form ($\mathcal{P}_B$) is invisible to any framework without the *Kāraṇa* domain.

The strict expressiveness hierarchy $LCN \supsetneq HMM \supsetneq BN$ of Theorem 9.3 is refined by the *Kāraṇa* Index to *KLN(κ=1)⊃KLN(1<κ<|P|)⊃HMM(κ=|P|,Dormant)⊃BN(κ=|P|,Vyakta)*, ordered by maximum representable Manifestation Information Gain. The BN achieves exactly zero MIG — all states are *Vyakta* at $t = 0$— while the UKC-KLN achieves the theoretical maximum $\mathcal{H}_{\oplus}(\mathcal{P}_{t^*-})$. The *Kāraṇa* Index $\kappa$is thus not merely a definitional quantity but a genuine network invariant that quantifies the distance between any given KLN and the fully degenerate (all-*Vyakta*, static) boundary.

The *Nyāya* Liberation Theorem (Theorem 10.2) establishes *apavarga* as a Manifestation Information Flow by two independent proof mechanisms — the Inheritance Operator path (Option A) and the Dissolution Cascade path (Option B) — whose convergence on the same conclusion is itself the formal content of a long-standing doctrinal question in *Nyāya* philosophy: whether liberation is primarily a discontinuation of the affliction chain through the fulfilment of the blueprint, or primarily an active destruction of false knowledge through an irreversible causal annihilation. The KLN framework demonstrates that these are not competing answers but formally equivalent descriptions of the same network event approached from the $\mathcal{P}_X$-face and the E_D-face of the same MIF cascade respectively.

The Information Budget Identity of Theorem 10.3 — $MIG(L_5, t^*, s^*) = \mathcal{H}_{\oplus}(\mathcal{P}_{t_0}) + D_{A_v}\ (t^*)$— closes the paper with a precise quantitative statement: conditioned existence, understood as the *Nyāya* six-node causal chain operating under UKC, accumulates *Avyakta* Debt at every Y-cascade registration event, and liberation dissolves this debt exactly. The debt is neither cancelled nor carried forward. It is resolved.

Kāraṇa-Lakṣaṇa Networks do not propose the Indian philosophical tradition as a source of intuitions to be later formalised in Western mathematical language. They propose it as the source of structural necessities whose mathematical expression — the four-state ontology, the tripartite observability partition, the dissolution edge, the blueprint encoding, the inheritance partition — cannot be recovered by restriction, generalisation, or re-parameterisation of any existing probabilistic framework. The dissolution gap is the proof of this claim. The *Nyāya* Liberation Theorem is its philosophical completion.

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Brief Profile of the Author:

Rameshchandra B. Ketharaju is a Hyderabad-based engineer, independent thinker, and *sādhaka* whose intellectual life spans two orders of inquiry that most minds keep entirely separate: the rigorous, formal world of emerging technologies and the inward, contemplative world of Sanātana Shastra.

His formation is grounded in engineering — trained at Chaitanya Bharati Institute of Technology, Osmania University, Hyderabad, with further study in management at the Institute of Public Enterprises — giving him a disciplined, systems-oriented mind that he brings equally to technological problems and to philosophical ones. He is a practitioner of TRIZ, the structured methodology of inventive thinking, which reflect a temperament drawn not merely to knowledge but to the *application* of knowledge — to building things that work.

What sets him apart is how he applies that same rigorous thinking to inner inquiry. His 2024 paper in the "International Journal on Eternal Wisdom and Contemporary Science" titled "*Bhoutika Shastra To Adi Bhoutika Shastra: A Methodological Exploration Through Quantum Mechanics and Neo-Quantum Physics"* reveals a thinker who has not simply read the Sanātana Shastra but has inhabited it with the seriousness of a *sādhaka* — one who maps the path from Sthūla (the gross, observable world) through Sūkṣma (the subtle, probabilistic domain) to Kāraṇa (the causal, unmanifest source) and ultimately toward Turīya, the fourth state of pure consciousness — using the formal structures of classical physics, quantum mechanics, and Neo-Quantum Mechanics theory as corresponding rungs of the same ladder.

Ketharaju thus represents a relatively rare type in contemporary Bhāratīya intellectual life — the engineer-sādhaka — one who moves fluently between the world of systems, innovation, and technological creation and the world of inner inquiry, Sanātana Shastra, and consciousness studies, treating both not as contradictions but as complementary expressions of the same deep curiosity toward understanding the nature of reality at every layer of its manifestation.

Statements and Declaration: I hereby declare that this manuscript is my original work and does not infringe on any rights of third parties to my knowledge. All sources have been duly acknowledged and cited to my knowledge. AI-assisted tools were used in the preparation of this manuscript for figure generation, structuring the flow of the sections, and manuscript review during development. The review assessed the language, mathematical rigor, novelty, contribution type, formalization stage, and IJEWCS publication readiness. I declare that I have no conflict of interest with my places of employment or anybody else in publishing this article. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

This paper series, is built to provide the mathematical foundation for the published paper titled "*Bhoutika Shastra To Adi Bhoutika Shastra: A Methodological Exploration Through Quantum Mechanics and Neo-Quantum Physics"* which was published in the December 2024 issue of "International Journal on Eternal Wisdom and Contemporary Science". *(https://gi4qc.org/archive).*

Notation and Glossary:

Part I. Mathematical Spaces and Index Sets

Symbol / Term	Meaning
$(\Omega, \mathscr{F}, P)$	Complete probability space underlying all KLN stochastic processes.
$\mathbb{R}_+$	Non-negative reals; codomain of proban-force η.
$(\mathcal{O}, \mathscr{F})$	Characteristic space: measurable space with ontological substrate $\mathcal{O}$, σ-algebra $\mathscr{F}$; elements $\chi \in \mathcal{O}$ are characteristics.
$\mathcal{P}$	Spatio-temporal domain: finite set of all *Lakṣaṇas* registered at (t, s); grows via *Uddeśa* events.
$\mathbb{T}$	Temporal index set: $\mathbb{T} \subseteq \mathbb{R}$.
$\mathcal{S}$	Spatial index set: finite label index; no topology required.
(t, s)	Spatio-temporal index: $t \in \mathbb{T}$, $s \in \mathcal{S}$.
$\mathbb{T} \times \mathcal{S}$	Full spatio-temporal index set.
$\mathscr{F}_t$	Filtration generated by the KLN process; $\mathscr{F}_t$ encodes all information available up to time t.
$\mathfrak{h} = \mathbb{R}_+^3$	*Vividhākāra* force space: convex cone in which the three-domain force triple ($\eta_{Sthūla}$, $\eta_{Sūkṣma}$, $\eta_{Kāraṇa}$) lives.

Part II. The *Lakṣaṇa*: Components of the Quintuple

Symbol / Term	Meaning
L	*Lakṣaṇa*: a generic or variable element $L \in \mathcal{P}$. Denotes any member of the spatio-temporal domain under general quantification — used in definitions, axioms, and theorems that apply to all or some *Lakṣaṇas* (e.g., "for every $L \in \mathcal{P}$," "there exists $L \in \mathcal{P}$"). Carries no implication about L's current state. Formalised as the quintuple.
$L = (\chi, \kappa, \eta, \mathcal{B}_L, \vec{P}_L)$	*Lakṣaṇa* quintuple: primitive KLN object encoding a characteristic, accessibility state, proban-force, blueprint component, and projection triple.
t	Temporal index: a generic element $t \in \mathbb{T} \subseteq \mathbb{R}$, ranging over the temporal index set of the spatio-temporal domain. Used in expressions evaluated at an arbitrary or variable time point, as opposed to t* which marks a specific stopping time.

s	Spatial index: a generic element s ∈ $\mathcal{S}$, ranging over the finite spatial index set. $\mathcal{S}$ carries no topology and functions as a pure label set (Definition 2.2). Used in expressions evaluated at an arbitrary or variable spatial location.
χ	Characteristic: the identifying property of a *Lakṣaṇa*; χ ∈ $\mathcal{O}$.
κ (accessibility state)	Four-valued state: {open, blocked, unmanifested, extinguished}. open = *Vyakta* achieved; blocked = Dormant, threshold pending; unmanifested = pure *Avyakta*; extinguished = η = 0, absorbing. Distinguished from the *Kāraṇa* Index κ = $\lvert\mathcal{P}/\sim_K\rvert$ by context
η	Proban-force: causal weight of a *Lakṣaṇa*; η ∈ $\mathbb{R}_+$. Ontological, independent of observability. η = 0 is absorbing (Axiom A6).
$\mathcal{B}_L$	Blueprint component of L: restriction 𝒷(DL)_L of the full *Dravya* blueprint to L.
$\vec{P}_L = (\pi_V, \pi_A\ , \pi_K)$	Projection triple: three domain-restricted observability projections of L at (t, s).
𝒷(D)	*Dravya-jñāna* blueprint: 𝒷(D) : {L ∈ $\mathcal{P}$(D) : η(L) > 0} → $\mathbb{R}_+$ × [0, T_max], assigning each *Lakṣaṇa* its causal weight and expected manifestation interval.
D_{root}	Unique root *Dravya* of a *Kāraṇa* equivalence class; the causal ground from which all class *Lakṣaṇas* derive their blueprint under UKC.
L_{root}	Root *Lakṣaṇa* under UKC; unique maximum element of $(\mathcal{P}, \leq_{H_C})$; causal ancestor of all other *Lakṣaṇas*.

Part III. Observability, Measurability, and State

Symbol / Term	Meaning
$Obs_{Sthūla}\,(L,\ t,\ s)$	Gross-domain observability: 1 iff L is detectable by *Pratyakṣa* (direct perception) at (t, s).
$Obs_{Sūkṣma}(L,\ t,\ s)$	Subtle-domain observability: 1 iff L is detectable by *Anumāna* or *Upamāna* at (t, s).
$Obs_{Kāraṇa}(L,\ t,\ s)$	Causal-domain observability: 1 for every L with η > 0; accessible via blueprint 𝒷. Pointwise ordering: $Obs_{Sthūla} \leq Obs_{Sūkṣma} \leq Obs_{Kāraṇa} \leq 1$.
Obs(L, t, s)	Composite observability: max($Obs_{Sthūla}$, $Obs_{Sūkṣma}$); equals 1 iff any *Pramāṇa* detects χ(L).
Meas(L, t, s)	Measurability: 1 iff (i) Obs = 1, (ii) threshold θ(L) is defined, and (iii) the activation question over O_ℋC(L) is formally decidable. Meas ≤ Obs pointwise.
σ(L, t, s)	State of L at (t, s): one of {*Vyakta*, *Avyakta*-Pure, *Avyakta*-Observable, Dormant, Extinguished}, determined by (κ, η, Obs, Meas).
$\vec{\sigma}(D, t, s) = (\sigma_{Sthūla}, \sigma_{Sūkṣma}, \sigma_{Kāraṇa})$	Multi-Domain State Vector of *Dravya* D: triple of projection-restricted state sets, one per domain. Components may simultaneously hold apparently contradictory values without logical inconsistency.
π_V(L, t, s)	*Sthūla* projection: returns (χ(L), κ(L,t,s), η(L,t)) if Obs*Sthūla* = 1, else ∅.
π_A(L, t, s)	*Sūkṣma* projection: returns (χ(L), κ(L,t,s), η(L,t)) if Obs*Sūkṣma* = 1, else ∅.
π_κ(L, t, s)	*Kāraṇa* projection: returns (χ(L), κ, η, 𝒷(DL)_L) for all L; always defined (Obs*Kāraṇa* = 1 for all η > 0); uniquely complete.
θ(L)	Dormant activation threshold: minimum proban-force sum over a causal hyperedge e ∈ $\mathcal{O}_{\mathcal{H}_C}$(L) required for L to transition Dormant → *Vyakta*; θ(L) ∈ $\mathbb{R}_+$, finite and unique by Axiom A9.
τ(L_{new})	*Uddeśa* stopping time: inf{t ≥ t_0 : U(L_{new}, t) = 1}; first time L_{new}'s *Uddeśa* condition is satisfied; $\mathcal{F}_t$-measurable.
τk	The k-th *Uddeśa* stopping time in the domain-expansion sequence under UKC.

Part IV. The *Dravya* and *Kāraṇa* Structure

Symbol / Term	Meaning
D	*Dravya* (Substantial Entity): non-empty D ⊆ $\mathcal{P}$ satisfying blueprint closure (unique D_{root} with $\mathcal{B}_L$ = 𝒷(D_{root})$\vert_L$ for all L ∈ D) and maximality; equivalently, a ∼K equivalence class on a connected component of ℋC.
L ∼_κ L′	*Kāraṇa* equivalence: L and L′ share a single blueprint root D_root, i.e., 𝒷L = 𝒷(D_root)_L and 𝒷L′ = 𝒷(D_root)_L′.
$\mathcal{P}_t/\sim_K\vert$	*Kāraṇa* quotient at time t; its cardinality counts distinct causal grounds in the domain.
κ (Kāraṇa Index)	Network invariant: $k(\mathcal{P}, t, s) = \lvert\mathcal{P}_t/\sim_\kappa\rvert$.
UKC	Universal *Kāraṇa* Condition: regime κ = 1 while
UKC epoch	Maximal interval [t_0, t*) during which κ = 1; exits if an external *Uddeśa* introduces a genuinely independent blueprint root.
Γ	Collapse Operator: under UKC, Γ : $\mathcal{P}$ → {L_{root}}, Γ(L) = L_{root} for all L. A surjective lattice homomorphism from ($\mathcal{P} \leq_{H_C}$) to the trivial lattice. Preserves: proban-force scalar structure, blueprint, causal ordering. Forgets: domain, state, and *Vividhākāra* graded distinctions.
ρn	Blueprint-transfer coefficient: ρn ∈ (0,1] such that η(n, λK) = ρn · η(L_root, λK) under UKC; encodes the fraction of L_root's causal force inherited by node n.

$\leq_{H_C}$	Hypergraph partial order: L $\leq_{H_C}$ L′ iff L′ is a causal ancestor of L in ℋC; L_root is the maximum element. Induced by EC only; ED edges do not contribute.

Part V. The *Vyāpinī* Hypergraph and Network Operators

Symbol / Term	Meaning
ℋ = (𝓟, E)	*Vyāpinī* hypergraph: directed hypergraph at the *Kāraṇa* level encoding *vyāpti* relations among *Lakṣaṇas*; $\mathcal{H} = \mathcal{HC} \cup \mathcal{HD}$.
ℋC = (𝓟, E_C)	Causal sub-hypergraph: acyclic directed hyperedges encoding causal activation (Axiom A3); governs proban-force propagation via f and the Dormant threshold.
ℋD = (𝓟, E_D)	Dissolution sub-hypergraph: directed hyperedges encoding active causal destruction via g; no counterpart in BN, HMM, or DBN.
E_C	Causal edge set: directed hyperedges (S, L) in ℋC.
ED	Dissolution edge set: directed hyperedges (eD, L) in ℋD.
$\mathcal{N}_{\mathcal{H}}(L)$	Hypergraph neighbourhood of L in the full Vyāpinī ℋ: $\mathcal{N}_{\mathcal{H}}(L)$= {S : (S, L) ∈ E}. The collection of all source-sets having a hyperedge targeting L (Definition 3.1).
$\mathcal{N}_{\mathcal{HC}}$(L)	Causal neighbourhood of L: $\mathcal{N}_{\mathcal{HC}}$(L) = {S : (S, L) ∈ EC}. Source-sets in the causal sub-hypergraph ℋC that can activate L. Used in the Dormant activation condition (Definition 3.4), threshold specification (Axiom A9), and measurability criterion (Definition 2.10).
$\mathcal{N}_{\mathcal{HD}}(L)$	Dissolution neighbourhood of L: $\mathcal{N}_{\mathcal{HD}}(L)$ = {S : (S, L) ∈ ED}. Source-sets in the dissolution sub-hypergraph ℋD whose manifestation annihilates L's proban-force via g. Appears in the MIF propagation bound (Theorem 8.4) and the Dissolution Expressiveness Gap (Proposition 9.1).
α(e, L)	*Vyāpti*-transfer coefficient: α(e, L) ∈ [0,1], fraction of L*'s proban-force transmitted to L via e. Conservation: $\sum_{L:(e,L)\in E_C} \alpha(e,L) \leq 1$ for every e ∈ EC.
f(ηt(L), ηt(L*), ℋC)	Causal transfer function: η(L) ← $\eta_t(L) + \sum_{e:L^*\in e,(e,L)\in E_C} \alpha(e,L)\cdot \eta_t(L^*)$. For L unreachable from L* in ℋC: f = ηt(L).
g(ηt(L), ηt(L*), ℋD)	Dissolution transfer function: g = 0 unconditionally upon manifestation of any source in O_ℋD(L). Irreversible; independent of ηt(L), σ(L), or any conditional probability.
⊗	Reconciliation operator: resolves $\vec{\sigma}$(D,t,s) to a single effective state at bifurcation points via the *Kāraṇa*-priority rule. Reduces under UKC to $\otimes(n) = \rho_n \cdot \eta_K^{root} \cdot f(r_n, u_n)$.
Parīkṣā-node 𝒩	A structurally designated bifurcation node in 𝓟 that maintains an open, revisable path-probability distribution πt(φ) over paths φ ∈ Π (Definition 3.7). Iits characteristic χ(B) is the basis against which χ(L*) is tested.
B	Basis of a *Parīkṣā*-node: B ⊆ 𝓟, the set of characteristics χ(L*) whose manifestation triggers Tunneling revision T at 𝒩. Formalises the Nyāya Trisūtri principle (Axiom A5).

Part VI. The Manifestation Information Flow

Symbol / Term	Meaning
Asterisk convention.	The superscript * serves two distinct roles in this paper. On **L*, t*, s*** it is an **event marker**: each symbol identifies the specific Lakṣaṇa, time, and spatial index of the current MIF event, and is re-bound at each new manifestation event in a sequence — the same symbol L* names a different Lakṣaṇa in each MIF expression.
L*	Manifesting *Lakṣaṇa*: the specific L ∈ 𝓟 currently undergoing the *Avyakta*-to-*Vyakta* transition that triggers the MIF. σ(L*, t*−) ∈ {Avyakta, Dormant}; σ(L*, t*+) = *Vyakta*. In the path probability formula (Definition 8.1), L* ranges as a bound variable over the currently manifested basis ℳt(B) = {L ∈ B : σ(L, t, s) = *Vyakta*}. Re-bound at each MIF event.
t*	Manifestation time: the stopping time t* = inf{t ≥ t_0 : σ(L*, t) = *Vyakta*}, measurable with respect to ℱt (Theorem 8.1). The specific moment at which MIF(L*, t*, s*) fires. Re-bound at each MIF event in a sequence.
s*	Manifestation spatial index: the specific element s* ∈ 𝒮 at which L*'s *Avyakta*-to-*Vyakta* transition occurs. Part of the full event specification (t*, s*) ∈ 𝕋 × 𝒮. Re-bound at each MIF event.
(L*, t*, s*)	MIF event triple: always appear together as the argument of MIF(·) = (Ψ, Υ, T). The asterisk on each is an event marker, not a permanent property of the symbol. In a network with multiple sequential MIF events, L*, t*, s* are re-bound at each event.
MIF(L*, t*, s*) = (Ψ, Υ, T)	Manifestation Information Flow: triple cascade triggered when L* transitions *Avyakta* → *Vyakta* at (t*, s*). All three components fire simultaneously.
Ψ	Proban-Force Cascade: first MIF component; operates in two simultaneous modes. causal mode: f-updates via ℋC. dissolution mode: g-annihilation via ℋD. Terminates in O(
Υ	*Uddeśa* Enablement Cascade: second MIF component; evaluates $\Lambda_{blocked}$ frozen at t^{*-} and registers newly enabled *Lakṣaṇas*: 𝓟: $\mathcal{P}_{t^*+1} \leftarrow \mathcal{P}_{t^*} \cup L_{new}$ for each qualifying L_{new}.
T	Tunneling Revision: third MIF component; revises path distribution πt at every *Parīkṣā*-node whose basis contains χ(L*): π_{t^*+1} ← T(π_{t^*}, L*).

$\Lambda_{blocked}$	Set of *Uddeśa*-blocked *Lakṣaṇas*: those whose *Uddeśa* condition is not yet satisfied. Evaluated and frozen at t^{*-} for each MIF cascade. Finite by Axiom A2.
t^{*-}	Moment immediately before t*; pre-MIF network state.
t*+	Moment immediately after t*; post-MIF network state.
$\mathcal{H}_{\oplus}(\boldsymbol{\mathcal{P}}, t, s)$	Stratified entropy: $\mathcal{H}_{\oplus}(P, t, s) = -\sum_{\varphi\in\Pi} \pi_t(\varphi) \log \pi_t(\varphi)$. $\mathcal{H}_{\oplus}= 0$ iff π_t is a point mass. Finite for all t by Axiom A2.
MIG(L*, t*, s*)	Manifestation Information Gain: $MIG(L^*, t^*, s^*) = \mathcal{H}_{\oplus}(\mathcal{P}_{t^{*-}}, t^{*-}, s^*) = \sum[\mathcal{H}_{\oplus}(\mathcal{P}_{t^{*-}}, t^{*-}, s^*)\| F_{t^{*-}}]$
MIG = MIG_{φ} + MIGY + MIGT	Additive MIG decomposition into contributions from the Ψ-cascade (force revision), Y-cascade (domain expansion), and T-cascade (path revision).
MIGY(L*, t*, s*)	Y-component of MIG: entropy increment from *Lakṣaṇas* newly registered from $\Lambda_{blocked}$; non-positive (registration adds entropy).
$D_{Av}(t^*)$	*Avyakta* Debt: $D_{Av}(t^*) = \sum_{k:\tau_k<t^*} \|MIG_Y(L_{\tau_k}, \tau_k, s)\|$
Π	Path space of a *Parīkṣā*-node: set of all complete paths consistent with its bifurcation structure; finite by Axiom A2.
πt(φ)	KLN path probability: $\pi_t(\varphi) = \frac{[\pi_0(\varphi, \mathcal{M}_t(B)) \cdot \Pi_{L^* \in \mathcal{M}_t(B)} w(L^*, t)]}{Z_t}$. A valid probability measure on Π.
$\mathscr{M}$t(B)	Currently manifested basis at t: {L ∈ B : σ(L, t, s) = *Vyakta*}.
w(L*, t) = ηt(L*)	Path probability weight of L* at t: proban-force value, strictly positive at *Vyakta* transition.
Zt	Path probability normalisation: Zt = Σφ π0(φ, $\mathscr{M}$t(B)) · ΠL* w(L*, t) > 0 by Axiom A5.
$\pi_0(\varphi)$	Initial path distribution: prior probability of path φ at t_0; non-degenerate by Axiom A5 (∃ φ* with $\pi_0(\varphi^*) > 0$).

Part VII. The Spatio-Temporal Inheritance Operator

Symbol / Term	Meaning
Φ	Spatio-Temporal Inheritance Operator: partitions $\boldsymbol{\mathcal{P}}(E_1)$_{t*⁻} into four disjoint subsets at the moment E_2 manifests. Unique (Thm 8.10) and force-conserving (Thm 8.9).
$\boldsymbol{\mathcal{P}}_C$	Continued *Lakṣaṇas*: persist in E_1 after t*, grounded in E_1's own causal identity; η unchanged or evolving by E_1's own dynamics.
$\boldsymbol{\mathcal{P}}_X$	Discontinued *Lakṣaṇas*: entire proban-force was rooted in E_2's *Avyakta* phase; ηt*+1(L) = 0 for all L ∈ $\boldsymbol{\mathcal{P}}_X$ upon E_2's manifestation.
$\boldsymbol{\mathcal{P}}_I$	Inherited *Lakṣaṇas*: characteristic χ transfers from E_1 to E_2; a copy L̃ is created with $\chi\tilde{L}$= χ(L) and $\eta\tilde{L}$= ρ · η(L), ρ ∈ (0,1]; enters $\boldsymbol{\mathcal{P}}(E_2)$.
$\boldsymbol{\mathcal{P}}_B$	Blueprint-Transferred *Lakṣaṇas*: *Kāraṇa*-domain *Lakṣaṇas* of E_1 whose blueprint $\mathscr{B}$ is transmitted to E_2 as the foundational $\mathcal{B}_{D_{E2}}$; the *Saṃskāra*, deep structural impressions.
ρ (transfer coefficient)	Fraction ρ ∈ (0,1] of η(L) carried into the inherited copy L̃ ∈ $\boldsymbol{\mathcal{P}}$I; ensures force conservation across the inheritance event.

Part VIII. Probability Structures and Martingales

Symbol / Term	Meaning
Ft	Total latent force process: $F_t = \sum_{L:\, \sigma(L,t)\in(Avyakta, Dormant)} \eta_t(L)$; sum of proban-forces of all non-manifested, non-extinguished *Lakṣaṇas*.
F∞	Almost-sure limit of Ft under UKC: F∞ = 0 a.s. by Doob's supermartingale convergence theorem.
$\mathbb{E}[F_{(t+1)} \mid \mathcal{F}_t] \le F_t$	Supermartingale property of Ft: expected next-period latent force does not exceed the current force.
O(f(n))	Big-O asymptotic upper bound: a quantity q(n) is O(f(n)) if there exist constants c > 0 and n_0 such that q(n) ≤ c · f(n) for all n ≥ n_0. In this paper, n = |$\boldsymbol{\mathcal{P}}$| (domain cardinality) and the bound O(|$\boldsymbol{\mathcal{P}}$|²) states that the total number of computational steps in a single MIF execution grows no faster than a fixed constant multiple of the square of the domain size, regardless of network topology or proban-force values. Used in Theorem 8.4 (MIF Propagation Bound) and Theorem 8.5 (MIF Monotone Extinguishment Bound).

Part IX — Sanskrit and Philosophical Terms (Alphabetical order)

Term	Meaning in the KLN Framework
Amśa principle (अंश)	The *Jyotiṣa* principle that the same *graha* (planetary body) expresses different *Lakṣaṇas* at the *rāśi*, *navāṃśa*, and *daśāṃśa* levels simultaneously without contradiction, because each expression is relative to a different resolution domain; formal analogue of the multi-domain projection triple
Anumāna (अनुमान)	Inference: the *Pramāṇa* grounding $Obs_{Sūkṣma}$ via logical deduction from *hetu* (reason) to *sādhya* (probandum)
Apavarga (अपवर्ग)	Liberation / cessation: the sixth node L_5 of the *Nyāya* causal chain; *Avyakta* throughout [t_0, t*), its manifestation at t* triggers the full MIF cascade extinguishing all prior chain nodes, registering the *Mokṣa Lakṣaṇa*, and resolving the entire *Avyakta* Debt
Āvirbāva (आविर्भाव)	Arising: the process by which *Avyakta* crosses into *Vyakta*; formally the MIF cascade

Avyakta (अव्यक्त)	Unmanifest: the state in which a *Lakṣaṇa* exists in $\mathcal{P}$ with η > 0 but has not completed its *Vyakta* transition. Two sub-states: Pure *Avyakta* (Obs = 0) and Observable-*Avyakta* (Obs = 1, Meas = 0). Causally active through the *Vyāpinī* despite epistemic inaccessibility
Dormant	*Measurable-Avyakta: κ = blocked ∧ Meas = 1 ∧ threshold θ(L) defined but not yet met; the epistemically tractable sub-state of Avyakta. Predicted existence; manifestation is a function of accumulated proban-force*
Doṣa (दोष)	Negative disposition / affliction: node L_1 in the *Nyāya* causal chain, arising from *mithyājñāna*
Dravya (द्रव्य)	Substantial entity: a subset D ⊆ $\mathcal{P}$ satisfying blueprint closure and maximality; the locus of causal identity that persists across *Lakṣaṇa* manifestations
Dravya-jñāna-kriyātmikā (द्रव्यज्ञानक्रियात्मिका)	The fifth dimension: *Dravya* (matter, the substantive), *Jñāna* (knowledge, the inferential), *Kriyātmikā* (action, the practically oriented). Every *Lakṣaṇa* in $\mathcal{P}$ carries both an ontological and a *Kriyātmikā* dimension
Duḥkha (दुःख)	Suffering / structured noise: node L_4 in the *Nyāya* causal chain; the *Avyakta* Debt accumulation phase
Extinguished	Absorbing state: η = 0. No *Pramāṇa*, MIF, Tunneling, or Inheritance event can restore force; permanent by Axiom A6
Hetvābhāsa (हेत्वाभास)	Fallacious reason / pseudo-probans: a *hetu* (reason) that appears to establish *vyāpti* but is defective; in KLN, the condition corresponding to total proban-force annihilation — the *Lakṣaṇa* loses its inferential force irreversibly, as per the combustion principle of Axiom A6
Janma (जन्म)	Conditioned manifestation / birth: node L_3 in the *Nyāya* causal chain
Kāraṇa (कारण)	Causal / blueprint: the third and deepest observability domain; accessible via the blueprint $\mathscr{B}$(D); every *Lakṣaṇa* with η > 0 is *Kāraṇa*-observable; the domain of the uniquely complete projection operator π_K
Lakṣaṇa (लक्षण)	Distinguishing mark or characteristic; the primitive object of the framework, formalised as the quintuple $(\chi, \kappa, \eta, \mathcal{B}_L, \overrightarrow{P_L})$. In *Nyāya* epistemology, the definitive property that identifies a subject of inquiry
Mahābhūta (महाभूत)	Gross physical elements: the *Sāṃkhya* category of gross-perceptible material reality; corresponds to the *Sthūla* observability domain in KLN
Mahat / *Kāraṇa* (महत् / कारण)	The cosmic intellect / causal ground: the deepest level of the *Sāṃkhya* ontology; corresponds to the *Kāraṇa* observability domain and the blueprint encoding $\mathscr{B}$(D) in KLN
Mithyājñāna (मिथ्याज्ञान)	False knowledge / misapprehension: the root node L_0 of the *Nyāya* causal chain; the unique source of the chain's UKC structure under $\sim_K$; targeted by the dissolution edge from L_5 in Option B of the Liberation proof
Mokṣa Lakṣaṇa (मोक्षलक्षण)	The post-liberation mode of existence: L_*mokṣa* ∈ $\Lambda_{blocked}$ (t^{*-}) whose *Uddeśa* condition is conditioned on complete extinguishment of L_0–L_4; registered in the Y-cascade of MIF(L_5), confirming Y ≠ ∅
Parīkṣā (परीक्षा)	Examination / inquiry: in KLN, a designated bifurcation node in the network at which the path probability π_t is revised by the Tunneling operator T upon relevant *Lakṣaṇa* manifestation
Pariṇāma (परिणाम)	Transformation / unfolding: the *Sāṃkhya* doctrine that the *Avyakta* does not instantaneously produce the *Vyakta* but does so through temporal development; formalised by Axiom A7 (Blueprint Persistence) and the Inheritance Operator Φ
Pramāṇa (प्रमाण)	Instrument of valid knowledge: the epistemic access mechanism that determines observability. Four *Pramāṇas*: *Pratyakṣa* (direct perception, grounds $Obs_{Sthūla}$), *Anumāna* (inference, grounds $Obs_{Sūkṣma}$), *Upamāna* (analogy, grounds $Obs_{Sūkṣma}$), *Śabda* (testimony, currently unrepresented as a blueprint-revision operator)
Pratyakṣa (प्रत्यक्ष)	Direct perception: the *Pramāṇa* grounding $Obs_{Sthūla}$ = 1; gross-domain access
Pravṛtti (प्रवृत्ति)	Motivated action: node L_2 in the *Nyāya* causal chain, arising from *doṣa*
Śabda (शब्द)	Testimony: the fourth *Pramāṇa*; not yet formalised in the current framework; identified as a blueprint-revision operator requiring future treatment
Sākṣī / *Sākṣībhāva* (साक्षी / साक्षीभाव)	Witness-consciousness: the bare witness state recognised in *Nyāya* and *Vedānta* traditions in which a *Lakṣaṇa* is present to consciousness without passing through any *Pramāṇa*; identified as the basis for a proposed sixth epistemic regime (Witnessed-*Vyakta*) not yet formally incorporated into the quintuple
Saṃskāra (संस्कार)	Deep structural impression: the *Kāraṇa*-domain *Lakṣaṇas* whose blueprint encoding $\mathscr{B}$ is transmitted to a new entity E_2 as the foundational $\mathscr{B}$(D_{E_2}); formalised as the $\mathcal{P}$_B component of the Inheritance Operator Φ
Sthūla (स्थूल)	Gross / manifest / particle-level: the first observability domain, corresponding to direct perceptual access (*Pratyakṣa*); the domain of the projection operator π_V
Sūkṣma (सूक्ष्म)	Subtle / inferential: the second observability domain, accessible by *Anumāna* or *Upamāna*; the domain of the projection operator π_A
Tanmātra (तन्मात्र)	Subtle elements: the *Sāṃkhya* category of subtle, inferable properties prior to gross manifestation; corresponds to the *Sūkṣma* observability domain in KLN

Tirobhāva (तिरोभाव)	Dissolution: the process by which *Vyakta* returns to *Avyakta* or is extinguished; formally the dissolution transfer g and the dissolution edge architecture $\mathscr{H}D$
Uddeśa (उद्देश)	Registration event: the measurable transition by which a new *Lakṣaṇa* L_new enters $\mathcal{P}$ when its *Uddeśa* condition $U(L_{new}, t) = 1$ is first satisfied. The $\tau(L_{new})$ stopping time is measurable w.r.t. $\mathscr{F}_t$
Upamāna (उपमान)	Analogy / comparison: the *Pramāṇa* grounding $Obs_{Sūkṣma}$ via structural similarity
Vivartavāda (विवर्तवाद)	*Advaita Vedānta* doctrine of apparent multiplicity on an unchanging ground: the many are genuine expressions of the one without independent existence. Formalised in KLN as the Collapse Operator Γ and the UKC: $\|\mathcal{P}\|$ grows without bound while $\|\mathcal{P}/\sim_K\| = 1$
Vividhākāra (विविधाकार)	Multi-formed: the reality that the same *Lakṣaṇa* may express differently across network relationships, resolutions, and temporal indices. Formalised as the *Vividhākāra* force space $\mathfrak{h} = \mathbb{R}_+^3$
Vyakta (व्यक्त)	Manifested: the state σ = *Vyakta* in which κ = open and η > 0; the gross-perceptible expression of a *Lakṣaṇa*. From *Sāṃkhya*: the expressed, perceptible world arising from *Avyakta*
Vyāpinī (व्यापिनी)	All-pervading: the directed hypergraph $\mathscr{H} = (\mathcal{P}, E)$ encoding invariable concomitance (*vyāpti*) relations. Active connective medium — not a passive container — propagating force across all three domains
Vyāpti (व्याप्ति)	Invariable concomitance: the logical relation of pervasion between a *hetu* (reason) and *sādhya* (probandum) in *Nyāya* inference; formalised in KLN as the hyperedge structure of $\mathscr{H}$ and the *vyāpti*-transfer coefficient α(e, L)

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Larson, Gerald James (1969). *Classical Sāṃkhya: An Interpretation of Its History and Meaning*. Delhi: Motilal Banarsidass. 2nd ed. 1979. ISBN: 978-8120805033. *Chapters cited*: ch. 3 (the three-level ontology of *Mahat*/*Kāraṇa*, *Tanmātra*/*Sūkṣma*, and *Mahābhūta*/*Sthūla*; formal basis for the KLN tripartite observability partition); ch. 4 (the enumeration and ordering of the twenty-five *tattvas*; basis for the blueprint encoding $\mathscr{B}(D)$ and the ordered causal structure of $\mathscr{H}C$); ch. 5 (the *pariṇāma* doctrine of continuous temporal unfolding from cause to effect without destruction of the causal ground; formal basis for Axiom A7, Blueprint Persistence).

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III. Mathematics: Probability Theory and Martingales

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networks; provides the DBN reference for Proposition 9.1, which establishes that the KLN dissolution gap holds against dynamic Bayesian networks as well as static BNs and HMMs); ch. 17 (Markov models and hidden Markov models: the generalisation from HMM to dynamic BN, used to establish the scope of the expressiveness hierarchy in Theorem 9.3 and the three-axis proof of Proposition 9.1).

Citation Index:

Gautama / Nyāya Sūtra

Sūtra	Location in paper	Purpose
1.1.1–1.1.3	Section 1.1	Formal basis for the *Vyāpinī* as an active connective medium encoding *vyāpti* relations
1.1.3	Definition 3.5 (*Parīkṣā*-node); Axiom A5	*Nyāya Trisūtri*: the non-degeneracy clause for valid inference; basis for the non-degeneracy requirement $\pi_0(\varphi^*) > 0$
1.1.21–1.1.22	Section 10 preamble	The *Nyāya* doctrine of *apavarga* as terminal liberation; L_s as MIF event
1.1.22	Proof of Theorem 10.2, Option B	The specific *Nyāya* doctrine that *apavarga* actively destroys *mithyājñāna*; formal basis for the dissolution edge $(e_D, L_0) \in E_D$

Īśvarakṛṣṇa / Sāṃkhyakārikā

Kārikā	Location in paper	Purpose
Kārikās 3–9	Section 5 preamble	*Sāṃkhya pariṇāma* doctrine: *Avyakta* produces *Vyakta* through temporal unfolding; basis for the Spatio-Temporal Inheritance Operator Φ
Kārikā 3	Axiom A3	The acyclic causal order of the *Sāṃkhya Tattva* hierarchy; cause necessarily precedes effect

Shankara / Brahmasūtrabhāṣya

Passage	Location in paper	Purpose
§2.1.14 (*vivartavāda*)	Section 6.1	*Advaita Vedānta* doctrine of apparent multiplicity on an unchanging ground; formal basis for the UKC and the duality of Theorem 6.1
§2.1.14	Definition 6.3 (Collapse Operator Γ)	The Collapse Operator as the mathematical correlate of *vivartavāda*
§2.1.14	Proof of Theorem 6.2	Γ's forgetting of domain distinctions as the formal content of *vivartavāda*

Larson 1969

Chapter	Location in paper	Purpose
Ch. 3	Section 2.2 (Observability Domain Partition)	Three-level *Sāṃkhya* ontology: *Mahābhūta* (gross), *Tanmātra* (subtle), *Mahat*/*Kāraṇa* (causal); formal basis for the three observability domains *Sthūla*, *Sūkṣma*, *Kāraṇa*
Ch. 3	Section 1.1	The *Sāṃkhya* paired categories *Avyakta*/*Vyakta* and the process of *āvirbāva* and *tirobhāva*
Ch. 5	Axiom A7 (Blueprint Persistence)	*Pariṇāma* as a monotone temporal function from *Avyakta* to *Vyakta* without destruction of the causal ground

Matilal 1986

Chapter	Location in paper	Purpose
Ch. 2	Definition 3.5 (*Parīkṣā*-node); Axiom A5	*Nyāya Trisūtri* and the formal structure of valid inference; basis for non-degeneracy and path revisability
Ch. 5	Section 3 preamble; Definition 3.1 (*Vyāpinī*)	The *Vyāpinī* doctrine: *vyāpti* as active connective medium, not passive container; basis for $\mathscr{H}$ as a causal propagation structure
Ch. 10	Section 10 preamble	The full *Nyāya* causal chain from *mithyājñāna* to *apavarga* and the treatment of liberation as a network-restructuring event

Radhakrishnan 1929

Volume / Chapter	Location in paper	Purpose
Vol. II, Ch. 9	Section 6.1	*Advaita Vedānta* as the limit of the *Nyāya–Sāṃkhya* ontology; *vivartavāda* as the doctrine that reconciles the UKC duality

Doob 1953

Theorem	Location in paper	Purpose
Theorem 4.1 (supermartingale convergence)	Section 6.4.1; Lemma 8.1 (body); Lemma 8.1 (Doob corollary)	Convergence of the non-negative supermartingale F_t to $F_\infty \geq 0$ a.s.; the absorbing behaviour of the total latent force process

Williams 1991

Theorem	Location in paper	Purpose
Theorem 11.5 (martingale convergence)	Section 6.4.1; Lemma 8.1 (Doob corollary); Proof of Theorem 6.4 Phase II	The quantitative upcrossing form of Doob's theorem; establishes $F_t \to F_\infty = 0$ a.s. under UKC and licenses $\mathcal{H}_\oplus = 0$ as the absorbing post-collapse state

Cover and Thomas 2006

Section	Location in paper	Purpose

§2.4	Proof of Corollary 9.3	Entropy of the symmetric distribution; HMM achievability of $\mathcal{H}_{\oplus}/|\boldsymbol{\mathcal{P}}|$ in the doubly-stochastic case
§2.6	Proof of Theorem 6.6	Sub-additivity of Shannon entropy; basis for the κ-monotone entropy bound max-MIG ≤ $\mathcal{H}_{\oplus}/\kappa$
§2.8	Proof of Theorem 6.4 Phase I	Data processing inequality; basis for $\mathcal{H}_{\oplus}$ non-decrease during Y-cascade registration events
Chs. 7–8	Background	Rate-distortion theory and channel capacity; background context for the MIG information-gain formalism

Birkhoff 1940

Chapter	Location in paper	Purpose
Ch. 2	Lemma 6.1 (body); Lemma 6.1	Definition of lattice, join, meet, and lattice homomorphism; formal basis for characterising $(\mathcal{P}, \leq_{\mathcal{H}_c})$ as a lattice under UKC and Γ as a surjective lattice homomorphism
Ch. 2	Theorem 6.2 (body)	Lattice-homomorphism background
Ch. 5	Background	Complete lattices and fixed-point results; background for the UKC collapse structure

Davey and Priestley 2002

Chapter	Location in paper	Purpose
Ch. 2	Lemma 6.1 (body); Lemma 6.1	Poset and lattice definitions; complementary reference to Birkhoff for the lattice-theoretic background of the proof
Ch. 2	Theorem 6.2 (body)	Lattice-homomorphism background
Ch. 5	Proof of Theorem 6.2, Step 5	Lattice congruences; basis for the kernel characterisation ker(Γ) = $\sim_K$

Pearl 1988

Chapter	Location in paper	Purpose
Ch. 3	Section 1.2	Original formulation of the binary epistemic partition (present/absent) that KLN generalises
Ch. 3	Theorem 9.1 (body); Proof of Theorem 9.1	Verification that KLN probability reduces to the standard Bayesian posterior under the all-*Vyakta*, static-domain restrictions
Ch. 4	Background	d-separation, conditional independence; background for Axiom A3 acyclicity
General	Section 9.1	Cited as authority for the expressiveness of the BN class in establishing the strict hierarchy

Darwiche 2009

Chapter	Location in paper	Purpose
Ch. 2	Section 1.2	The standard BN definition and binary-state node representation; characterises the structural limitation that motivates KLN
Ch. 2	Theorem 9.1 (body)	Co-cited with Pearl (1988) for the BN degenerate-case embedding

Rabiner 1989

Section	Location in paper	Purpose
HMM definition and forward-backward / Viterbi algorithms	Theorem 9.2 (body); Proof of Theorem 9.2	Formal definition of the HMM five-tuple (S, O, A, B, π_0); verification that KLN path probability $\pi_t(\varphi)$ matches the HMM posterior under the Markovian-Dormant restrictions
General	Section 9.1	Cited as authority for the expressiveness of the HMM class in establishing the strict hierarchy

Murphy 2012

Chapter	Location in paper	Purpose
Ch. 10	Section 9.1	Dynamic Bayesian networks as the generalisation of static BNs; establishes the scope of Proposition 9.1(dissolution gap holds against DBNs as well)
Ch. 17	Proposition 9.1; Proof of Proposition 9.1	HMM-to-DBN generalisation; the three-axis proof of the dissolution expressiveness gap applies to the full DBN class

Acronyms and Abbreviations:

This appendix collects all acronyms and abbreviations used in the paper, listed alphabetically for reference. Where an acronym corresponds to a formally defined object, the relevant definition is cross-referenced.

Acronym	Full Form	First Defined / Used
BN	Bayesian Network	Section 1.2; Theorem 9.1
CPT	Conditional Probability Table	Section 1.2; Theorem 9.1
DAG	Directed Acyclic Graph	Section 3.1 ($\mathscr{H}$C); Axiom A3

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DBN	Dynamic Bayesian Network	Proposition 9.1;
DOI	Digital Object Identifier	Bibliography
HMM	Hidden Markov Model	Section 9; Theorem 9.2
ISBN	International Standard Book Number	Bibliography
KLN	Lakṣaṇa-Conditional Network	Abstract; Section 1
MIF	Manifestation Information Flow	Abstract; Definition 4.3
MIG	Manifestation Information Gain	Definition 4.5
UKC	Universal Kāraṇa Condition	Abstract; Definition 6.2

Notes on Terms Used Without Abbreviation:

The following technical terms appear frequently in the paper without abbreviation but may be unfamiliar to readers from probabilistic machine learning backgrounds. Brief glosses are provided here; full formal definitions are given in the Notation and Glossary and in the referenced definitions.

Avyakta — Unmanifest. The state of a *Lakṣaṇa* that exists in $\mathcal{P}$ with positive proban-force $\eta > 0$ but has not yet crossed the *Vyakta* threshold. Causally active through the *Vyāpinī* despite epistemic inaccessibility. Definition 2.11.

CPT — Conditional Probability Table. In a standard Bayesian network, the CPT of a node X specifies P(X | Parents(X)) for all configurations of X's parent nodes. Every entry is a probability value in [0, 1]. The CPT is the standard mechanism by which inhibitory influence is encoded in a BN: setting P(X = high | Inhibitor = active) = ε lowers the conditional probability of X but does not eliminate its structural presence from the network. This is the key contrast with the KLN dissolution edge, which sets $\eta(L) = 0$ unconditionally at the ontological level, bypassing the conditional probability architecture entirely. See Section 1.2 and Proposition 9.1 for the formal distinction.

Dravya — Substantial entity. A non-empty subset $D \subseteq \mathcal{P}$ satisfying blueprint closure and maximality; equivalently, a *Kāraṇa* equivalence class on a connected component of $\mathscr{H}$C. Definition 2.3.

Lakṣaṇa — Distinguishing characteristic. The primitive object of the KLN framework, formalised as the quintuple $(\chi, \kappa, \eta, \mathscr{B}_L, \vec{P}_L)$. Definition 2.8.

MIF — Manifestation Information Flow. The triple cascade (Ψ, Y, T) triggered when a *Lakṣaṇa* transitions from any *Avyakta* sub-state to *Vyakta*. The three components fire simultaneously: Ψ propagates proban-force updates, Y registers newly enabled *Lakṣaṇas*, and T revises path-probability distributions at *Parīkṣā*-nodes. Definition 4.3.

MIG — Manifestation Information Gain. The expected reduction in stratified entropy $\mathcal{H}_{\oplus}$ at (t*, s*) when L* manifests. Decomposes additively into $MIG_\Psi + MIG_Y + MIG_T$. Non-negative; maximised at the UKC root event. Definition 4.5.

***Parīkṣā*-node** — Designated bifurcation node maintaining a revisable path-probability distribution π_t. The node at which the Tunneling operator T fires upon manifestation of relevant *Lakṣaṇas*. Definition 3.7.

Pramāṇa — Instrument of valid knowledge. The four classical *Nyāya Pramāṇas* are *Pratyakṣa* (direct perception), *Anumāna* (inference), *Upamāna* (analogy), and *Śabda* (testimony). They govern the observability indicators $Obs_{Sthūla}$ and $Obs_{Sūkṣma}$. Definition 2.5; Section 1.1.

UKC — Universal *Kāraṇa* Condition. The regime in which the *Kāraṇa* Index $\kappa = |\mathcal{P}/\sim_K| = 1$ while $|\mathcal{P}|$ grows without bound: every *Lakṣaṇa* in $\mathcal{P}$ derives its blueprint from a single root *Dravya* while the domain cardinality is unbounded. The paradigm instance is the six-node *Nyāya* causal chain (Theorem 10.1). Definition 6.2.

Vyakta — Manifest. The state σ = *Vyakta* in which κ = open and η > 0; the gross-perceptible expression of a *Lakṣaṇa*. Definition 2.11.

Vyāpinī — All-pervading. The directed hypergraph $\mathscr{H} = (\mathcal{P}, E)$ encoding invariable concomitance (*vyāpti*) relations among *Lakṣaṇas*, partitioned into causal edges E_C and dissolution edges E_D. Definition 3.1.