

Dark Matter Defined: A Structural Consequence of Pre-Metric Instantiation

William Smith¹

¹Independent Researcher, ORCID: 0000-0002-0951-3254

Abstract

Dark matter is conventionally characterised phenomenologically, by its gravitational effects and lack of electromagnetic interaction, rather than by an ontological definition. In this work we propose a minimal structural definition of dark matter derived from first principles of quantum foam admissibility and instantiation. We show that the minimal stable outcome of non-metric quantum admissibility under enforced closure is a triadic relational structure. Under extreme relativistic instantiation conditions, such structures may preserve closure while losing electromagnetic coherence. We define dark matter as the dominant class of closure-preserving but electromagnetically silent triadic instantiations. This definition reproduces the essential phenomenology of dark matter without introducing new particles, modifying gravity, or invoking ad hoc fields.

1 Introduction

Despite extensive observational evidence, dark matter remains ontologically undefined. Most contemporary approaches posit new particles or fields whose properties are tuned to reproduce gravitational phenomena [1]. While successful phenomenologically, such approaches rarely address why a non-luminous, collisionless, gravitationally active sector should exist at all.

Here we adopt a different strategy. Rather than proposing a new constituent, we ask what forms of structure are permitted by quantum admissibility prior to metric instantiation—before the emergence of ordinary matter, time, and space—and which of these survive as gravitationally persistent but electromagnetically silent entities. We argue that dark matter emerges naturally as a structural phase of instantiation, not as a separate substance.

2 Quantum Foam and Admissibility

We consider a pre-metric Quantum Foam (QF) regime, following Wheeler [2], characterised by three minimal conditions:

1. Non-nullity: the domain is not empty.

2. Non-smoothness: no differentiable or continuous transitions are admitted.
3. Non-metric admissibility: no geometric, spatial, or temporal structure is presupposed.

Under these conditions, the Quantum Foam supports a *scope of admissibility*: the complete ensemble of all non-metric possibilities permitted by the above axioms. This scope does not expand dynamically in time but saturates logically. The approach to instantiation is therefore time-free and corresponds to a boundary in admissibility space rather than a temporal process.

3 Instantiation and Enforced Closure

Instantiation occurs when admissibility alone becomes insufficient and closure is enforced. Closure is not an entity or point-like object but a global constraint requiring admissible distinctions to resolve into mutually consistent relational structures. Instantiation is therefore triggered rather than gradual.

The minimal structure capable of satisfying enforced closure without invoking metric geometry is triadic. Dyadic configurations fail to resolve vector-like constraint imbalance, while higher arity is unnecessary at first instantiation. The triad thus represents the minimal stable and generative unit.

A triadic instantiation consists of four distinguishable elements (Figure 1):

Node A	local relational role
Node B	local relational role
Node C	local relational role
Closure orientation	global constraint

The closure orientation is non-local and enforces cyclic constraint resolution across the triad. In this framework, the asymptotic approach to enforced closure performs the fundamental work of instantiation, while Inflation arises as the only consistent metric response once spacetime and time have emerged.

4 Generativity of Triadic Closure

Once closure is enforced, the triadic structure is not merely stable; it is generative. Cyclic constraint circulation eliminates free vector endpoints and enforces persistence without invoking time, dynamics, or geometry.

The orientations of the three local relational roles, together with the orientation of cyclic closure, provide sufficient structure to account for fractional participation, sign, threefold relational identity, and conjugation. These properties later appear, under metric projection, as charge magnitude, charge sign, colour, and particle–antiparticle distinction, without requiring additional degrees of freedom.

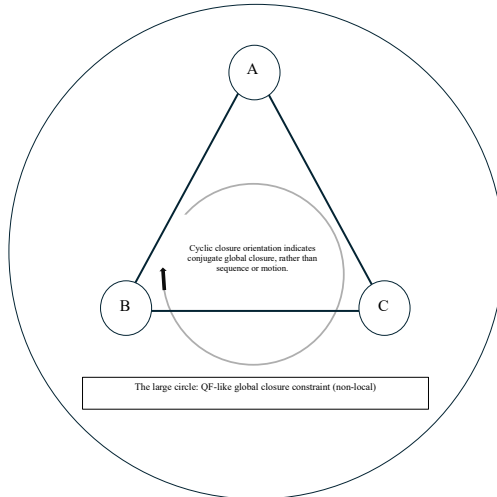


Figure 1: **Schematic representation of minimal triadic closure.** Nodes A, B, and C denote relational roles rather than spatial positions, and the connecting lines indicate constraint relations rather than metric distances or angles. The circular marker denotes a QF-like global closure constraint, enforcing non-local consistency across the triad. The circular arrow indicates cyclic closure orientation, distinguishing conjugate global resolutions rather than ordered traversal or temporal evolution. The diagram is included to enforce a pre-metric interpretation and should not be read as an embedding in space or time. Cyclic closure orientation indicates conjugate global closure, not sequence or motion.

5 Definition of Dark Matter

Under extreme relativistic instantiation conditions, such as those prevailing in the early universe, triadic structures may undergo electromagnetic decoherence while preserving closure. In such cases, cyclic closure persists and gravitational bookkeeping remains, while electromagnetic coupling fails.

We therefore propose the following definition:

Dark matter is the class of instantiated triadic structures whose closure persists while electromagnetic coherence does not.

This definition is structural rather than particulate and does not invoke new fields or interactions.

6 Phenomenological Consistency

This definition naturally reproduces the defining observational properties of dark matter. Persistent closure accounts for gravitational interaction and lensing [3]. Loss of electromagnetic coherence explains invisibility and absence of radiative cooling. The resulting structures are effectively collisionless, leading to extended halo formation and swarming behaviour characteristic of phase-space-dominated dynamics.

Importantly, no modification of general relativity is required, and standard cosmological phenomenology is preserved.

7 Relation to Inflation and Effective Descriptions

In this framework, pre-metric admissibility defines the space of possible structure, while enforced closure converts this scope into generative reality. What cosmological inflation later parameterises dynamically is the metric-time re-expression of this generative phase, not its origin.

Similarly, particle-based dark matter models may be interpreted as effective descriptions of closure-preserving, electromagnetically silent triadic structure within metric spacetime.

8 Discussion and Outlook

This work does not claim exclusivity, nor does it propose a new particle or interaction. It provides a minimal ontological definition of dark matter grounded in admissibility and instantiation logic. Future work may explore observational discriminants associated with coherence loss, relations to neutrino sectors, and analogies with transparency-dominated heavy-ion collisions.

9 Conclusion

Dark matter need not be postulated. It is the expected dominant outcome of triadic instantiation under enforced closure when electromagnetic coherence fails. In this sense, dark matter is not exotic; it is what remains when quantum admissibility is constrained into reality under relativistic stress.

References

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- [3] D. Clowe, M. Bradač, A. H. Gonzalez, M. Markevitch, S. W. Randall, C. Jones, and D. Zaritsky. A direct empirical proof of the existence of dark matter. *Astrophysical Journal Letters*, 648:L109–L113, 2006.