Structure Before Interaction: Interpretive Foundations of Coherence in Cosmology

Abstract

Contemporary cosmology has achieved substantial explanatory success in accounting for the formation and evolution of large scale structure. Within the ΛCDM framework, gravitational dynamics, dark matter, and dark energy together explain the observed distribution of galaxies, clusters, and the cosmic web. Numerical simulations reproduce large scale statistical regularities with high fidelity, while observational techniques such as gravitational lensing enable increasingly precise reconstructions of mass distributions. Despite this success, the interpretive status of structure itself remains largely implicit. Cosmological models describe how structure evolves under interaction, but they presuppose rather than clarify the conditions under which coherent structure is intelligible at all.

This paper advances a foundational interpretive claim: structure is explanatorily prior to interaction. Interactions, forces, and dynamics operate only where coherent configuration is already admissible. The priority defended here is a constraint on cosmological explanation, not a claim about the generative order of reality. It concerns explanatory dependence rather than temporal sequence, causal production, or physical mechanism. The paper does not propose a new cosmological model, introduce new physics, or modify gravitational dynamics. Its aim is to clarify a structural presupposition that cosmological practice already relies upon but does not explicitly articulate.

By structure, I mean the persistence of coherent configuration sufficient for intelligible interaction, independent of the specific forces or dynamics governing that interaction. Structure, in this sense, is not reducible to spatial arrangement, mathematical formalism, or physical scaffolding. It names a more basic condition: that configurations remain admissible rather than collapsing into incoherence. Cosmological explanations routinely presuppose this condition when modelling gravitational collapse, virialisation, and hierarchical assembly, yet rarely treat it as an object of interpretation in its own right.

Dark matter provides the clearest empirical context in which this explanatory priority becomes visible. Across a wide range of phenomena, including scale invariant halo profiles, gravitational lensing reconstructions, and cluster collisions, dark matter marks persistence where luminous matter dissipates, interacts, and fragments. In cluster collisions, baryonic gas undergoes shock heating and dispersion, while the inferred mass distribution associated with dark matter remains coherent across the event. These observations do not require the introduction of new forces or mechanisms and are already accommodated within standard cosmology. Their

significance for the present analysis lies in what they reveal about the relationship between interaction and persistence.

On this basis, the paper advances a role based interpretation of dark matter. Rather than defining dark matter by particle identity or interaction channels, it is interpreted by its explanatory role in sustaining coherent structure where interaction bound matter dissipates. This interpretation does not alter the empirical role, parameterisation, or theoretical treatment of dark matter within ΛCDM, and remains neutral with respect to its microphysical nature.

To articulate persistence without invoking new dynamics, the paper introduces the concept of structural suspension. Structural suspension is introduced solely as a terminological device for tracking explanatory dependence and carries no physical, causal, or dynamical commitment. It names the continued admissibility of configuration that cosmological explanation already presupposes.

The contribution of the paper is interpretive and foundational. It does not compete with empirical cosmology or particle physics research, but clarifies a presupposition that underlies cosmological modelling. Physics, on this view, does not merely describe interaction within structure. It presupposes structure as a condition of intelligibility. Making that presupposition explicit is the task of the present work.

1. Introduction

Contemporary cosmology has achieved remarkable explanatory success. Within the ΛCDM framework, gravitational dynamics, dark matter, and dark energy together account for the observed distribution of galaxies, clusters, and large scale structure across cosmic time. Numerical simulations reproduce statistical regularities with high fidelity, while observational techniques such as gravitational lensing enable increasingly precise reconstructions of mass distributions. Few areas of contemporary science exhibit such close alignment between theory, simulation, and observation.

Despite this success, a foundational question remains largely implicit within cosmological explanation: what must already hold for coherent structure to be intelligible at all. Cosmological models describe how structure evolves under interaction. They specify how matter collapses, disperses, equilibrates, and responds to forces. Yet these descriptions presuppose, rather than explain, the possibility of coherent configuration in the first place. Interaction presupposes configuration. Dynamics presuppose persistence. The conditions under which something can remain structured enough to undergo interaction are rarely treated as an object of interpretation in their own right.

This paper addresses that presupposition. It does not advance a new cosmological model, propose a physical mechanism, or revise gravitational dynamics. Its aim is interpretive. It seeks to clarify a structural condition that cosmological practice already relies upon when modelling interaction, persistence, and large scale coherence. The contribution lies not in revising empirical theory, but in making explicit a condition of intelligibility that such theory already presupposes.

The central claim advanced here is that structure is ontologically prior to interaction. This claim concerns explanatory dependence rather than temporal sequence, causal production, or physical mechanism. Interactions, forces, and dynamics operate only where coherent configuration is already admissible. The priority defended here is a constraint on cosmological explanation, not a claim about the generative order of reality. It identifies an ordering of dependence implicit in cosmological practice rather than a metaphysical hierarchy imposed upon the world.

By structure, I mean the persistence of coherent configuration sufficient for intelligible interaction, independent of the specific forces or dynamics governing that interaction. Structure, in this sense, is not reducible to spatial arrangement, mathematical formalism, or physical scaffolding. It names a more basic condition: that configurations remain admissible rather than collapsing into incoherence. Cosmological explanations routinely presuppose this condition when modelling gravitational collapse, virialisation, and hierarchical assembly, yet rarely treat it as an object of interpretation in its own right.

Dark matter provides the clearest empirical context in which this explanatory priority becomes visible. Across a wide range of phenomena, including scale invariant halo profiles, gravitational lensing reconstructions, and cluster collisions, dark matter marks persistence where luminous matter dissipates, interacts, and fragments. In merging galaxy clusters, baryonic gas undergoes shock heating and dispersion, while the inferred mass distribution associated with dark matter remains coherent across the event. These observations are well established within standard cosmology and do not require the introduction of new forces or mechanisms. Their significance for the present analysis lies in what they reveal about the relationship between interaction and persistence.

Contemporary philosophy of science has long attended to questions of structure, particularly in debates concerning structural realism and the interpretation of physical theories. Such accounts typically focus on what survives theory change or on the ontological status of relations. The present analysis adopts a different orientation. Rather than defending realism about structure, it examines the role that persistence of configuration plays in enabling cosmological explanation at all. The concern is not with what exists, but with what must already hold for interaction based explanation to be intelligible.

The argument proceeds by examining cosmological practice rather than by proposing speculative metaphysics. It draws on well established empirical phenomena and standard modelling assumptions to show that interaction based explanations presuppose a background of coherent configuration. This background is not generated by interaction, nor explained by it. It is assumed. Making this assumption explicit allows the explanatory roles of structure and interaction to be properly distinguished.

The remainder of the paper is organised as follows. Section 2 examines how cosmological practice implicitly distinguishes between interaction based dynamics and the persistence of coherent configuration. Section 3 reviews empirical cases in which interaction bound matter dissipates while coherence persists. Section 4 develops a role based interpretation of dark matter grounded in these phenomena. Section 5 introduces the concept of structural suspension as a descriptive term for persistence without mechanistic implication. Section 6 articulates the claim that structure is ontologically prior to interaction and clarifies its scope. Section 7 addresses potential objections and limits. Section 8 concludes by reflecting on the implications of this interpretive clarification for cosmological explanation.

2. Structure and Interaction in Cosmological Practice

Cosmological explanation is ordinarily articulated in the language of interaction. Gravitational dynamics govern the motion of matter, determine collapse and virialisation, and shape the evolution of large scale structure over cosmic time. Within the ΛCDM framework, these dynamics are specified with considerable precision, and their consequences are explored through increasingly sophisticated numerical simulations. Observational programmes and simulations together describe how matter aggregates, disperses, equilibrates, and responds to forces. Yet the success of these explanations depends on a distinction that is rarely made explicit: the distinction between the dynamics that operate within a configuration and the conditions that make configuration itself intelligible.

In practice, cosmological models presuppose the persistence of coherent configuration across time and interaction. Structure formation simulations begin with initial conditions defined over an extended spatial domain and track the evolution of density perturbations under gravity. These simulations assume that matter distributions remain sufficiently coherent to support gravitational amplification, halo formation, and hierarchical assembly. The possibility that configuration itself might fail, by dissolving into incoherence rather than evolving dynamically, is not modelled because it is not part of the explanatory target. Persistence is treated as a background condition rather than an outcome requiring explanation.

This presupposition becomes especially clear when considering the explanatory role of gravity. Gravity is invoked to explain how matter moves, aggregates, and responds to potentials. It accounts for trajectories, collapse rates, and equilibrium states. What gravity does not explain is why a gravitationally meaningful configuration exists in the first place. A gravitational potential presupposes a structured domain in which forces can be defined and applied. The explanatory work of gravity therefore operates downstream of a more basic condition, namely that there is something structured enough for gravitational interaction to be intelligible at all.

Numerical simulations make this dependence explicit. Large scale structure simulations rely on discretised representations of matter evolving under gravitational interaction within a stable computational domain. Their fidelity depends on the persistence of this domain across time steps and parameter variations. While simulations explore sensitivity to initial conditions, resolution, and numerical schemes, they do not model the admissibility of configuration as such. The stability of the underlying configuration is assumed as a prerequisite for any dynamical evolution to be computed. This mirrors the situation in cosmological theory more broadly, where interaction is modelled against a backdrop of assumed coherence.

A similar pattern appears in observational cosmology. Techniques such as gravitational lensing reconstruct mass distributions by inferring coherent structures from their effects on light propagation. These reconstructions presuppose that mass distributions form stable and intelligible configurations over observational timescales. The explanatory focus is on mapping and characterising these structures, not on accounting for their admissibility. Even when observations reveal disruption, collision, or dissipation, they do so against the assumption that a coherent configuration remains available for reconstruction and interpretation.

This distinction between interaction and persistence is not a defect in cosmological practice. It reflects a legitimate division of explanatory labour. Physics aims to describe how systems behave given certain conditions, not to explain why those conditions obtain at the most fundamental level. However, when this division remains implicit, it can obscure the interpretive status of key explanatory elements. In cosmology, it can encourage the assumption that structure is simply the outcome of interaction, rather than a condition that interaction presupposes.

The tendency to treat structure as an outcome of dynamics is understandable. Cosmological narratives often describe structure as emerging from initial fluctuations through gravitational instability. Such narratives are accurate at the level of dynamical explanation. Given an admissible configuration, gravitational interaction explains how inhomogeneities grow and organise into larger structures. Yet even in these narratives, the emergence in question is dynamical rather than foundational. The initial fluctuations are already configurations within an admissible domain. Gravitational amplification explains how these configurations evolve, not why configuration itself is possible.

Clarifying this distinction has interpretive consequences. If structure is treated solely as the product of interaction, then all explanatory weight is placed on forces and dynamics. Persistence becomes invisible as an explanatory condition, even though it is relied upon throughout cosmological modelling. By contrast, recognising that interaction presupposes structure allows the explanatory roles of dynamics and persistence to be properly separated. Dynamics explain change within configuration. They do not explain the possibility of configuration as such.

This separation does not deny that structures can fragment, transform, or dissolve. Nor does it deny that interaction plays a central role in shaping the observable universe. Rather, it asserts that the intelligibility of these processes depends on a background of coherent configuration. Without such a background, interaction based explanation would lack its subject matter. There would be nothing sufficiently structured for forces to act upon or for dynamics to describe.

Cosmological practice therefore implicitly relies on the priority of structure over interaction in the sense of explanatory dependence. This reliance is visible in the assumptions embedded in simulations, in the methods of observational reconstruction, and in the interpretive frameworks used to describe cosmic evolution. Making this reliance explicit does not alter cosmological theory or practice. It clarifies the conditions under which that practice is possible.

The next section turns to empirical phenomena that make this distinction especially vivid. By examining cases in which interaction bound matter dissipates while coherent configuration persists, it becomes possible to see more clearly the priority of structure that cosmological explanation relies upon but does not explicitly name.

3. Empirical Persistence Without Dissipation

The distinction between interaction and persistence becomes most visible in empirical contexts where interaction bound matter dissipates while coherent configuration remains. Contemporary cosmology contains multiple such cases. These phenomena are not anomalous, nor do they challenge standard theory. They are well established within ΛCDM and routinely described in observational and simulation based work. Their significance for the present analysis lies not in their novelty, but in what they reveal about the relationship between interaction and coherent structure.

One of the most robust examples is the regularity of dark matter halo structure. Across a wide range of mass scales, from dwarf galaxies to rich clusters, inferred mass distributions exhibit strikingly similar density profiles. These regularities persist despite substantial variation in formation history, environment, and baryonic processes. Star formation, gas cooling, and energetic feedback differ markedly across systems, yet the overall structural form of the halo remains stable. This persistence cannot be attributed to luminous matter alone, whose behaviour is highly sensitive to local conditions and dissipative processes. Instead, it indicates that coherent configuration is maintained independently of the interaction bound components that undergo dissipation.

Gravitational lensing provides a second line of evidence. Lensing reconstructions infer mass distributions solely through their influence on the propagation of light, without reference to electromagnetic emission or interaction. These reconstructions consistently reveal extended and coherent mass structures that do not coincide with luminous matter. In many systems, the lensing signal extends well beyond the visible boundaries of galaxies or clusters and remains stable across observational timescales. What lensing tracks is not interaction, but configuration. The persistence of the inferred mass distribution is therefore revealed precisely where electromagnetic interaction is absent.

Cluster collisions make this pattern especially clear. In merging galaxy clusters, baryonic gas interacts strongly, undergoing shock heating, compression, and dissipation. The gas slows, heats, and disperses as a result of these interactions. At the same time, gravitational lensing reconstructions show that the dominant mass distribution remains coherent and spatially distinct from the dissipating gas. This separation between interaction bound matter and persistent configuration is well documented and uncontroversial. What matters for the present analysis is that interaction does not preserve the surviving structure, nor does it generate it. Interaction unfolds against a background of persistence that remains intact across disruption.

These phenomena are often described in terms of collisionless behaviour. Dark matter is said to pass through collisions because it interacts weakly with baryonic matter. While accurate at the level of interaction physics, this description does not address the interpretive question at issue here. Weak interaction explains why dark matter does not dissipate like gas. It does not explain why the resulting configuration remains coherent rather than dispersing or fragmenting. The absence of interaction is not sufficient, by itself, to account for persistence of structure.

The same pattern appears at larger scales. The cosmic web exhibits filamentary organisation extending across hundreds of megaparsecs. These structures persist across cosmic time despite local collapse, mergers, and energetic feedback. Baryonic matter flows, cools, reheats, and redistributes within this network, yet the overall configuration remains stable enough to guide structure formation across epochs. Once again, interaction shapes behaviour within the structure, but does not account for the admissibility of the structure itself.

Taken together, these empirical cases reveal a consistent feature of cosmological explanation. Coherent configuration persists across dissipation, collision, and transformation of interaction bound matter. This persistence is not explained by interaction alone, nor is it produced by continuous dynamical support. It is observed as a stable background condition against which interaction becomes intelligible.

Importantly, recognising this persistence does not undermine standard cosmology. On the contrary, it helps to explain why cosmological models are successful. By operating within a domain where coherent configuration is already admissible, models can focus on describing how matter behaves rather than why configuration is possible at all. The distinction between interaction and persistence is therefore not a criticism of cosmological practice, but an articulation of a presupposition upon which that practice depends.

Dark matter plays a central role in making this presupposition visible. Where luminous matter dissipates, the inferred mass distribution remains. Where interaction bound components fragment, coherence persists. This does not imply that dark matter causes persistence, nor that persistence constitutes a new physical effect. Rather, dark matter evidence reveals the presence of coherent configuration precisely where interaction based explanation reaches its limits.

It is essential to emphasise that this analysis remains neutral with respect to the microphysical nature of dark matter. Whether dark matter consists of weakly interacting particles, axions, or some other entity is orthogonal to the interpretive point being made. Across all candidate theories, the role of dark matter in cosmological explanation remains the same. It functions as the component through which coherent configuration persists when interaction bound matter dissipates. This role is invariant under changes in particle identity.

The empirical phenomena reviewed in this section therefore motivate a distinction between interaction and coherence. Interaction explains change within configuration. Coherence explains why there is a configuration within which change can occur. Persistence without dissipation makes this distinction visible in practice and prepares the ground for a role based interpretation of dark matter developed in the next section.

4. Dark Matter Beyond Interaction

The empirical patterns examined in the previous section motivate a shift in interpretive emphasis. In standard cosmological explanation, dark matter is introduced to resolve discrepancies between observed dynamics and the distribution of luminous matter. Rotation curves, gravitational lensing signals, and cluster dynamics indicate the presence of additional gravitating mass that does not participate in electromagnetic interaction. Within ΛCDM, dark matter is therefore treated as a non luminous component that contributes to gravitational dynamics while remaining otherwise weakly interacting. This framing is empirically correct, but it does not exhaust the explanatory role dark matter plays within cosmological practice.

Most discussions of dark matter focus on questions of identity. What kind of entity could supply the missing mass. What interaction channels might it possess. How might it be detected directly or indirectly. These questions are central to astroparticle physics and motivate extensive experimental and observational programmes. The present analysis does not contest their importance. Instead, it brackets them in order to clarify a different issue, namely what role dark matter already plays in cosmological explanation independently of its microphysical nature.

Across a wide range of contexts, dark matter functions as the component through which coherent configuration persists when interaction bound matter dissipates. This role is evident in halo regularities, gravitational lensing reconstructions, and cluster collisions. In each case, the behaviour of luminous matter is shaped by interaction, while the inferred mass distribution remains coherent across disruption. Dark matter therefore does not merely add gravitational influence. It marks the continued admissibility of configuration where interaction based processes fail to preserve it.

This role based interpretation differs from both reductive and eliminative accounts. It does not reduce dark matter to a placeholder awaiting particle discovery, nor does it eliminate dark matter in favour of modified dynamics. Instead, it treats dark matter as an indispensable explanatory element whose significance lies in what it makes visible. Dark matter evidence reveals that cosmological explanation presupposes persistence beyond interaction. It shows where coherence remains when interaction alone is insufficient to account for it.

A key feature of this interpretation is its invariance across competing theories of dark matter identity. Whether dark matter consists of weakly interacting particles, axions, sterile neutrinos, or some other entity, its explanatory role remains the same. In every case, dark matter is inferred because coherent structure persists where luminous matter does not. The robustness of dark matter evidence across observational contexts therefore reflects stability of explanatory role rather than commitment to a particular microphysical hypothesis.

At this point, a clarification is essential. To say that dark matter marks persistence is not to say that dark matter causes persistence. The present analysis does not attribute agency, force, or structural support to dark matter beyond what is already recognised in standard cosmology. Nor does it posit a new physical effect. The claim is interpretive rather than causal. Dark matter is the empirical site at which persistence becomes visible, not the mechanism by which persistence is produced.

This distinction allows the analysis to remain within its proper scope. Cosmological models continue to explain motion, collapse, and equilibrium through gravitational dynamics. Dark matter contributes to these explanations by supplying mass. What the present analysis adds is a clarification of why this contribution matters at a foundational level. Dark matter matters because it identifies where coherent configuration endures across processes that dissipate interaction bound matter. In doing so, it exposes a background condition upon which interaction based explanation depends.

Treating dark matter solely as a missing interaction term risks obscuring this role. When dark matter is framed only as an invisible particle that adds gravitational pull, its significance is collapsed into dynamics alone. Yet the empirical phenomena reviewed earlier show that what distinguishes dark matter is not merely its contribution to force, but its association with coherence across disruption. Interaction shapes behaviour within configuration. Persistence determines whether there is a configuration to be shaped.

Recognising this distinction does not require revision of cosmological theory. It requires only an adjustment in interpretive emphasis. Dark matter need not be elevated to a metaphysical principle, nor reduced to a provisional hypothesis awaiting elimination. It can be understood as a stable explanatory marker of persistence within cosmological explanation. This marker remains operative regardless of how future discoveries refine our understanding of dark matter composition.

This role based interpretation also clarifies the relationship between cosmology and dark matter detection programmes. Experimental efforts aim to identify the microphysical nature of dark matter. Their success or failure does not alter the interpretive point advanced here. Even if dark matter were eventually described in radically different physical terms, its role as the marker of persistence across interaction bound dissipation would remain intact.

Nothing in this role based interpretation alters the empirical role, parameterisation, or theoretical treatment of dark matter within ΛCDM.

This section has argued that dark matter should be interpreted beyond interaction, not by redefining its physics, but by clarifying its explanatory role. Dark matter evidence makes visible a distinction between interaction and coherence that cosmological practice already presupposes. The next section introduces the concept of structural suspension as a way of naming this persistence without invoking new mechanisms or extending beyond interpretive foundations.

5. Structural Suspension and Continuity

Structural suspension is introduced solely as a terminological device for tracking explanatory dependence and carries no physical, causal, or dynamical commitment. It does not posit a new force, field, mechanism, or form of support. Its purpose is to name a condition that cosmological explanation already presupposes but does not explicitly articulate: the continued admissibility of coherent configuration in contexts where interaction based processes dissipate or fragment luminous matter.

The need for such a term arises from a recurring interpretive difficulty. Empirical phenomena reviewed earlier show that coherent configuration persists across disruption, collision, and dissipation. These cases are often described using the language of weak interaction or collisionless behaviour. While accurate at the level of interaction physics, such descriptions leave unanswered the question of why configuration remains coherent rather than dispersing or becoming unintelligible. The absence of interaction explains why matter does not dissipate in a particular way. It does not explain why a configuration remains admissible as a structure.

Structural suspension addresses this gap without extending beyond interpretive analysis. Rather than asking what holds structure together in a force mediated sense, it asks under what conditions a configuration remains intelligible as a configuration at all. Suspension, in this context, does not imply support or counteraction. It implies only that structure remains available to explanation. Configuration persists not because it is actively maintained, but because it does not collapse into incoherence.

This distinction is essential for maintaining conceptual discipline. Terms such as support, binding, or stabilisation invite mechanistic interpretations. Structural suspension deliberately avoids these connotations. It refers to persistence without specifying how persistence is achieved. In doing so, it preserves neutrality with respect to physical realisation while allowing the explanatory role of persistence to be named and analysed.

Structural suspension also clarifies the relationship between coherence and observability. Much of cosmological observation depends on electromagnetic interaction. Yet many of the most stable structures in cosmology become visible precisely where electromagnetic emission is absent. Gravitational lensing reconstructs mass distributions without relying on light emission. Dark matter evidence emerges through the absence of electromagnetic interaction rather than its presence. Structural suspension captures this asymmetry by distinguishing persistence of configuration from modes of interaction or detection.

It is important to emphasise that structural suspension does not imply invariance or permanence. Structures evolve, merge, fragment, and dissolve over cosmic time. Suspension refers only to the continued admissibility of configuration during such processes. A structure can change profoundly while remaining intelligible as a structure. The cosmic web, for example, undergoes continual transformation while maintaining a coherent organisation within which interaction unfolds.

By naming this condition, structural suspension makes explicit a background assumption of cosmological modelling. Simulations assume that configurations remain coherent across time steps. Observational reconstructions assume that mass distributions remain stable enough to be inferred. Theories assume that there is something structured enough for forces to act upon. Structural suspension does not add to these assumptions. It renders them visible.

This visibility has interpretive consequences. When persistence is not named, it is often absorbed into dynamics by default. Structure is treated as if it were nothing more than the outcome of interaction. Structural suspension resists this collapse. It preserves the distinction between what interaction explains and what interaction presupposes. Dynamics explain change within configuration. Structural suspension marks the condition under which such explanation is possible.

The concept also helps to clarify the role of dark matter discussed in the previous section. Dark matter does not generate suspension, nor does it constitute suspension itself. Rather, dark matter evidence reveals where suspension obtains. Where luminous matter dissipates and interaction based explanation reaches its limits, coherent configuration remains. Structural suspension names this persistence without attributing it to a new physical cause.

In this way, structural suspension functions as an interpretive bridge. It connects empirical observation with the metaphysical claim advanced in the next section without collapsing either into the other. It allows the persistence of structure to be discussed explicitly while maintaining neutrality with respect to physical theory and mechanism.

This section has introduced structural suspension as a minimal descriptive concept for persistence of coherent configuration beyond interaction based explanation. The next section develops the central claim of the paper by arguing that the persistence captured by structural suspension reflects an ordering of explanatory dependence in which structure is ontologically prior to interaction.

6. Structure as Ontologically Prior to Interaction

The preceding sections have distinguished interaction based explanation from the persistence of coherent configuration and introduced structural suspension as a descriptive term for that persistence. This section develops the central claim of the paper: structure is ontologically prior to interaction. This claim concerns explanatory dependence rather than temporal sequence, causal production, or physical mechanism. It is offered as an interpretive clarification of what cosmological explanation already presupposes.

To say that structure is ontologically prior to interaction is to say that interaction presupposes structure as a condition of intelligibility. Forces, trajectories, and dynamical relations are defined only within a coherent configuration. Interaction explains how systems change. It does not explain why there is a system capable of change. Without admissible configuration, interaction based explanation has no subject matter. Explanatory dependence therefore runs from structure to interaction rather than the reverse.

This ordering is often obscured by the language of emergence used in cosmology. Structure is commonly described as emerging from initial fluctuations through gravitational instability. While accurate as a description of dynamical evolution, this language risks conflating two distinct explanatory levels. The emergence described by cosmological models concerns the evolution of patterns within an already admissible domain. It does not explain why such a domain exists or why configuration remains coherent rather than dissolving into incoherence. The priority claim articulated here makes this distinction explicit.

Empirical cases reviewed earlier reinforce this ordering. In cluster collisions, interaction bound matter dissipates while coherent configuration persists. Interaction does not generate the surviving structure, nor does it preserve it. Instead, interaction unfolds within a background of persistence that remains intact across disruption. The persistence of configuration is therefore not an effect of interaction, even though interaction shapes behaviour within it.

Recognising the ontological priority of structure does not diminish the role of physical explanation. Gravitational dynamics remain indispensable for explaining motion, collapse, and equilibrium. What changes is the interpretive understanding of what such explanations do. Physics explains how systems behave within a structured domain. It does not explain why that domain is structured in the first place. Acknowledging this limit clarifies the scope of physical explanation without undermining its success.

It is essential to emphasise the minimal nature of the priority claim. It does not assert that structure is a substance, a field, or an independent entity. Nor does it posit a metaphysical layer beneath physical reality. The claim is not that structure exists apart from interaction, but that interaction presupposes structure as a condition of intelligibility. This ordering is implicit in cosmological practice and becomes visible when interaction based explanation reaches its limits.

The claim also avoids collapse into epistemic or representational accounts. Structure, as used here, is not a feature of observation, modelling convenience, or conceptual scheme. It is inferred from stable patterns across multiple independent lines of empirical evidence, including lensing, dynamics, and large scale organisation. The priority of structure therefore concerns the conditions under which physical explanation operates, not the conditions under which observers describe the world.

At the same time, the analysis remains deliberately silent on the physical realisation of persistence. It does not identify structure with dark matter, spacetime, or any specific physical substrate. Nor does it claim that persistence is irreducible to future physical theory. The point is that current interaction based explanations already presuppose persistence and cannot account for it using interaction alone. Recognising this presupposition clarifies explanatory architecture without foreclosing further theoretical development.

This silence is a strength rather than a limitation. By resisting the temptation to specify mechanisms, the analysis avoids overreach and remains faithful to its interpretive aim. The task is not to explain how structure arises, but to clarify the conditions under which explanation begins. Structure, in this sense, is not an object of explanation within cosmology, but a condition of its intelligibility.

The consequence of this clarification is a reordering of explanatory emphasis. Interaction explains change. Structure explains intelligibility. Dynamics describe evolution. Persistence makes evolution describable. These distinctions do not introduce new entities or forces. They articulate relations of dependence that are already operative within cosmological explanation but rarely made explicit.

This section has argued that structure is ontologically prior to interaction in the sense of explanatory dependence. Interaction presupposes structure as a condition of intelligibility, while structure is not generated by interaction. The final section addresses potential objections to this claim and clarifies its limits and implications for cosmological explanation.

7. Objections, Clarifications, and Limits

The claim that structure is ontologically prior to interaction may invite several objections if misread as a metaphysical proposal or a revision of physical theory. This section addresses the most likely concerns and clarifies the limits of the analysis. Doing so is essential to preserve the interpretive scope of the paper and to prevent category errors in its evaluation.

A first objection is that the argument merely restates the role of gravity. On this view, persistence of coherent configuration is nothing over and above gravitational interaction itself. Gravity, it may be argued, already explains why matter remains structured rather than dispersing. This objection conflates interaction with intelligibility. Gravity explains motion, aggregation, and equilibrium within a configuration. It does not explain why a gravitationally meaningful configuration exists in the first place. A gravitational potential presupposes a structured domain in which forces can be defined. The priority claim does not deny the explanatory power of gravity. It clarifies the conditions under which gravitational explanation operates.

A second objection is that the argument implicitly proposes emergent gravity, modified dynamics, or a new physical substrate underlying interaction. This reading is incorrect. The paper does not advance a generative account of interaction, nor does it propose an alternative physical mechanism. It does not explain how gravity arises, nor does it suggest revisions to ΛCDM or general relativity. The claim concerns explanatory dependence rather than physical emergence. Interaction presupposes structure as a condition of intelligibility. No further physical claim is made.

A related concern is that the analysis introduces speculative metaphysics under the guise of interpretation. Cosmology, it might be argued, should restrict itself to empirically testable claims. This objection misunderstands the role of interpretive work in science. All physical theories rely on background assumptions that are not themselves explained within the theory.

Clarifying these assumptions does not add metaphysical content to the world. It clarifies the conceptual architecture of explanation. The present analysis does not posit new entities, forces, or causal relations. It articulates a presupposition already operative in cosmological practice.

Another objection is that treating structure as explanatorily prior risks rendering interaction secondary or dispensable. This is not the case. Interaction remains essential for explaining change, evolution, and observable behaviour. The claim is not that interaction is less real or less important, but that it is explanatorily downstream of structure. Without structure, interaction has nothing to act upon. Without interaction, structure would not evolve in the ways described by cosmology. The two are complementary but not symmetrical in explanatory dependence.

A further clarification concerns the status of dark matter within the argument. The paper does not redefine dark matter, nor does it claim that dark matter is identical with structure, persistence, or structural suspension. Dark matter remains an empirical component of cosmological models, characterised by its gravitational effects and lack of electromagnetic interaction. The role based interpretation advanced here concerns what dark matter evidence reveals about explanatory structure, not what dark matter fundamentally is. Confusing these levels would collapse interpretive clarification into ontological redefinition, which the analysis explicitly avoids.

It may also be objected that persistence itself demands explanation. Why, one might ask, does configuration persist rather than dissolve into incoherence. The present analysis does not deny the legitimacy of this question. It claims only that current interaction based cosmological explanation does not answer it. Recognising this limit does not foreclose future theoretical development. It marks a boundary between what cosmology presently explains and what it presupposes. Identifying such boundaries is a legitimate and necessary task for philosophy of science.

Finally, the analysis must be distinguished from epistemic claims about observation or representation. The priority of structure is not a claim about how scientists organise data, construct models, or interpret observations. It is a claim about what must already hold for interaction based explanation to be intelligible at all. Structure, as used here, is inferred from stable patterns across independent empirical contexts, including lensing, dynamics, and large scale organisation. It is not a projection of conceptual schemes or observational limitations.

Taken together, these clarifications show that the priority claim defended in this paper is disciplined and limited. It does not revise physical theory, propose new mechanisms, or compete with empirical research programmes. It clarifies an ordering of explanatory dependence that becomes visible when interaction based explanation reaches its limits.

With these objections addressed, the argument of the paper is complete. The concluding section summarises the central claims and reflects on their implications for the interpretation of cosmological explanation.

8. Conclusion

This paper has argued for a foundational clarification in the interpretation of cosmological explanation. Contemporary cosmology has achieved substantial success in describing how large scale structure forms and evolves under interaction. Within the ΛCDM framework, gravitational dynamics, dark matter, and dark energy together account for the observed distribution of matter across cosmic time. Yet this explanatory success rests on a presupposition that is rarely made explicit: that coherent structure is already admissible prior to interaction. Making that presupposition visible has been the central aim of this analysis.

The argument proceeded in stages. Section 2 showed that cosmological practice consistently relies on a distinction between interaction based dynamics and the persistence of coherent configuration. Simulations, observational reconstructions, and theoretical models assume that configuration remains admissible as a background condition for interaction. Section 3 demonstrated that this distinction becomes empirically salient in cases where interaction bound matter dissipates while coherent configuration persists. Halo regularities, gravitational lensing, and cluster collisions reveal persistence that is not explained by interaction alone. Section 4 reframed dark matter by its explanatory role rather than by microphysical identity, showing that dark matter functions as an empirical marker of persistence across disruption. Section 5 introduced the concept of structural suspension as a minimal descriptive term for this persistence without invoking new mechanisms. Section 6 articulated the central claim that structure is ontologically prior to interaction in the sense of explanatory dependence, and Section 7 clarified the limits of this claim and addressed potential objections.

The core conclusion can be stated succinctly. Interaction presupposes structure as a condition of intelligibility. Forces, dynamics, and causal relations describe change within a configuration, but they do not account for the possibility of configuration itself. Structure, understood as the persistence of coherent configuration sufficient for interaction, is therefore explanatorily prior to interaction. This priority is not temporal, causal, or generative. It concerns explanatory dependence within cosmological practice.

Recognising this ordering does not revise cosmological theory or diminish the role of physical explanation. Gravitational dynamics remain essential for explaining motion, collapse, and equilibrium. Dark matter remains an indispensable empirical component of ΛCDM. What changes is the interpretive understanding of what these explanations presuppose. Cosmology explains how systems behave given structure. It does not explain why structure is admissible in the first place. Acknowledging this boundary clarifies the scope of cosmological explanation without undermining its success.

The role based interpretation of dark matter developed here illustrates this point. Dark matter matters not only because it contributes to gravitational dynamics, but because it reveals where coherent configuration persists when interaction bound matter dissipates. This role is invariant across competing theories of dark matter identity and remains operative regardless of future discoveries concerning its microphysical nature. Dark matter evidence therefore tracks persistence rather than interaction alone.

The contribution of this paper is interpretive and foundational. It does not propose new physics, introduce mechanisms, or compete with empirical research programmes. It clarifies an explanatory presupposition that cosmological practice already relies upon but does not explicitly articulate. By distinguishing persistence from interaction and structure from dynamics, the analysis makes visible an ordering of dependence that underwrites cosmological explanation.

More broadly, the argument illustrates the importance of identifying the limits as well as the powers of scientific explanation. Physical theories describe how systems behave under specified conditions. They do not, and need not, explain the conditions of their own intelligibility. In cosmology, those conditions include the admissibility of coherent structure within which interaction becomes meaningful. Making this explicit strengthens rather than weakens the conceptual foundations of cosmological explanation.

With this clarification in place, cosmological explanation can be understood more clearly for what it is: a powerful account of change within a world whose structural coherence is already given. Identifying that coherence is not an endpoint, but a starting point.

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