ED-Entanglement: Non-Individuation, Gradient Sparsity, and the Preservation of a Single Participation Rule

Allen Proxmire
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Abstract
In the ED ontology, entanglement is not a nonlocal connection, a shared wavefunction, or a mysterious coordination across space. It is the structural consequence of creating systems in a regime of extremely sparse ED-gradients, where individuation has not yet occurred. When a high-ED parent system splits into low-ED fragments, those fragments inherit a single undeveloped participation rule. They do not possess distinct identities because they lack the internal ED-structure required to support them. Perfect correlations arise because the fragments are not yet different enough to disagree; spatial separation is irrelevant because distance does not create individuation. Measurement and decoherence force individuation by injecting ED and proliferating internal gradients, while mixed states reflect partial individuation. Entanglement swapping and teleportation are controlled manipulations of undeveloped participation rules, not transmissions of information. Entanglement, in ED, is the persistence of undeveloped identity — a single participation structure expressed in multiple locations until becoming forces it to fragment.

1. Standard Quantum Background
In the conventional quantum picture, entanglement is introduced as a property of the wavefunction: two systems are said to be entangled when their joint state cannot be written as a product of independent states. This mathematical condition predicts perfect correlations between measurements, even when the systems are separated by large distances. The formalism works flawlessly, but it offers no physical mechanism. The wavefunction is a computational object, not an ontology, and the correlations it encodes are treated as primitive facts rather than consequences of a deeper structure.

The standard account leaves several conceptual gaps. The correlations appear instantaneous, yet the theory provides no physical process linking the systems after separation. The systems behave as if they are not fully distinct, yet the theory does not explain what "distinctness" means or how it develops. Measurement is said to collapse the wavefunction, but the theory does not specify what physically changes or why. Decoherence is invoked to explain the loss of entanglement, but it is described as an environmental effect rather than a structural transition.

Quantum mechanics predicts entanglement with extraordinary accuracy, but it does not explain what entanglement *is*. It describes the correlations but not the structure that produces them. The result is a picture in which entanglement is treated as a fundamental mystery: a nonlocal connection between systems that are otherwise assumed to be separate.

In the ED ontology, entanglement is not a connection at all. It is the persistence of **non-individuation** in a regime of extremely sparse ED-gradients. When a system is created with too little internal ED to develop distinct participation rules, its fragments inherit a single participation structure. They do not influence each other across space; they simply have not yet become different enough to behave independently.
Entanglement is therefore not nonlocality. It is **undeveloped identity**.

2. ED Ontology: The Relevant Pieces

Entanglement in ED does not require new machinery. It emerges from the same structural elements that underlie every other phenomenon in the ontology. Only a few components are needed to make the mechanism inevitable.

(1) Event Density (ED).
ED measures how much becoming has accumulated in a region. Systems with high ED have rich internal structure; systems with low ED have almost none. ED is not a substance but a record of development.

(2) ED-Gradients.
Differences in ED determine how systems participate in the unfolding of the universe. ED-gradients define the available pathways for evolution, interaction, and differentiation. A system's identity is encoded in the structure of its internal ED-gradients.

(3) Multiplicity vs. Sparsity.
A system with many distinct ED-gradient pathways is high-multiplicity: it can evolve in many ways, scatter in many directions, and develop a rich internal identity.
A system with very few pathways is low-multiplicity: its behavior is tightly constrained, and its identity is undeveloped.

(4) Individuation.
To be a distinct physical object is to possess enough internal ED-structure to support its own participation rule. Individuation is not assumed; it is earned. Systems with sparse ED-gradients have not yet developed distinct identities.

(5) Decoherence as Re-Entry into High-Multiplicity Participation.
When a system interacts with its environment, ED-flow proliferates. New gradient pathways appear. The system becomes high-multiplicity, and its undeveloped identity collapses into a fully individuated one. This is the ED mechanism behind decoherence.

These components are sufficient to reinterpret entanglement as the persistence of **non-individuation**. When a system is created in a regime of extremely sparse ED-gradients, its fragments inherit a single participation rule. They do not influence each other across space; they simply have not yet become different enough to behave independently.

Entanglement is therefore not a connection. It is a **failure to differentiate**.

3. The ED Interpretation of Entanglement

In the ED ontology, entanglement is not a connection between distant systems. It is the structural consequence of creating objects in a regime where **individuation has not yet occurred**. When a high-ED system splits into two fragments, the resulting objects inherit the ED-structure of the parent. If the parent system had extremely sparse ED-gradients, the fragments begin life with almost no internal differentiation. They do not possess distinct participation rules; they share one.

3.1 Creation in a Low-ED Regime

Entangled systems originate from processes that produce fragments with **minimal internal ED**. Their ED-gradients are too sparse to encode separate identities. They are not two fully formed objects; they are two

expressions of one undeveloped ED-structure.

3.2 Non-Individuation

Because individuation requires internal ED-complexity, these fragments cannot yet behave independently. They have no internal structure that would allow them to disagree. They do not coordinate across space; they simply have not become different enough to diverge.

3.3 Propagation Without Development

As the fragments separate, they accumulate almost no internal ED. Their ED-gradients remain sparse, their participation rules remain undeveloped, and their identities remain unformed. Spatial separation does not create individuation; only ED-development does.

3.4 One Participation Rule, Two Locations

The perfect correlations observed in entanglement arise because the fragments are not yet distinct ED-objects.

They share a single participation rule inherited from the parent system. When one fragment is forced into individuation through measurement, the other must adopt the complementary participation rule because both were expressions of the same undeveloped structure.

Entanglement is therefore not nonlocality. It is the persistence of **a single participation rule expressed in multiple locations**.

4. Why Entanglement Correlations Are Perfect

In the ED ontology, the perfection of entanglement correlations is not surprising, mysterious, or in need of nonlocal influence. It is the direct consequence of **non-individuation**. Two fragments created in a regime of extremely sparse ED-gradients do not possess distinct participation rules. They are not two fully formed ED-objects; they are two expressions of a single undeveloped structure. Perfect correlations arise because there is nothing inside the fragments that could produce disagreement.

A system can only behave independently if it has accumulated enough internal ED to support its own participation rule. Entangled fragments have not. Their ED-gradients are too simple, too sparse, too undeveloped. They do not have the internal structure required to generate distinct outcomes. When one fragment is forced into individuation through measurement, the other must adopt the complementary participation rule because both were expressions of the same undeveloped identity.

This produces correlations that appear instantaneous, but no influence is transmitted. The fragments do not communicate; they simply complete the same participation rule in different locations. The universe is not coordinating them across space. It is allowing a single undeveloped ED-structure to finish becoming.

There is no signaling because there is nothing to signal.
There is no hidden information because there is no internal structure to hide it.
There is no nonlocality because the fragments were never fully separate.

The correlations are perfect because the systems are not yet different enough to be imperfect.

5. Why Spatial Separation Is Irrelevant

In the ED ontology, spatial separation has no bearing on entanglement because **distance does not create individuation**. ED-structure does. Two fragments created in a regime of extremely sparse ED-gradients do not possess distinct participation rules. They are not two fully developed ED-objects; they are two locations where a single undeveloped ED-structure is being expressed. Moving them apart does not change this. Separation in space does not add ED, does not enrich their internal gradients, and does not generate new participation pathways.

Individuation requires internal development. It requires the accumulation of ED-structure that allows a system to behave independently. Entangled fragments lack this structure. Their ED-gradients are too simple to support distinct identities. They remain non-individuated regardless of how far they travel. Spatial distance does not introduce multiplicity; only ED-development can do that.

This is why entanglement correlations persist across arbitrary separations. The universe is not coordinating distant systems. It is allowing a single undeveloped participation rule to unfold in multiple locations. The fragments do not influence each other; they simply complete the same rule because neither has become different enough to do otherwise.

In ED, entanglement is not a violation of locality. It is a demonstration that **locality is irrelevant to systems that have not yet individuated**.

6. Measurement as Forced Individuation

In the ED ontology, measurement is not the collapse of a wavefunction. It is the moment when a low-ED system is forced to accumulate enough internal ED to become a distinct object. A measurement device is a high-multiplicity structure: it contains vast ED-gradients, countless participation pathways, and an enormous capacity to absorb and generate ED-flow. When an undeveloped fragment interacts with such a system, it cannot remain sparse. The interaction injects ED into the fragment, proliferating its internal gradients and creating new participation pathways.

This proliferation is individuation.

The fragment acquires enough internal ED-structure to support its own participation rule. It becomes a distinct ED-object rather than an expression of an undeveloped one. The single participation rule inherited from the parent system collapses into a fully developed rule specific to the fragment.

This is what quantum mechanics calls “collapse.”
But nothing collapses.

Something *forms*.

The fragment does not choose an outcome; it becomes capable of having one. The measurement device does not reveal a pre-existing property; it forces the system to develop the internal ED-structure required to possess that property at all. The apparent randomness of outcomes reflects the fact that individuation is a structural transition, not a deterministic evolution.

Once one fragment individuates, the other must adopt the complementary participation rule because both were expressions of the same undeveloped ED-structure. No influence is transmitted. No information travels. The second fragment simply completes the same individuation process in a way that preserves the single participation

rule they previously shared.

Measurement is therefore not a special quantum event. It is **the structural moment when non‑individuation ends**.

7. Decoherence as Environmental Participation

In the ED ontology, decoherence is not the gradual fading of a quantum wavefunction. It is the moment when an undeveloped ED‑structure is forced into individuation by its environment. Every environment is a high‑multiplicity system: it contains vast ED‑gradients, countless participation pathways, and a continuous influx of ED‑flow. When a low‑ED fragment interacts with such an environment, it cannot remain sparse. The interaction injects ED into the fragment, proliferating its internal gradients and generating new participation pathways.

This proliferation is individuation.

The fragment acquires enough internal ED‑structure to support its own participation rule. It becomes a distinct ED‑object rather than an expression of an undeveloped one. The single participation rule inherited from the parent system collapses into a fully developed rule specific to the fragment.

Decoherence is therefore the environmental version of measurement.
Measurement is forced individuation by a designed high‑multiplicity apparatus.
Decoherence is forced individuation by everything else.

The environment does not “observe” the system. It overwhelms it. The low‑ED fragment cannot maintain its sparse gradient structure in the presence of a high‑multiplicity partner. The universe does not allow undeveloped identities to persist when surrounded by rich ED‑flow. The fragment is pulled into participation with the environment, and its undeveloped identity dissolves into a fully individuated one.

This is why entanglement is fragile.
It is not a delicate quantum resource.
It is a temporary failure of individuation.

The moment the environment injects enough ED to create new gradient pathways, the single participation rule collapses. The fragments become distinct ED‑objects, and the correlations vanish because the structural condition that produced them — non‑individuation — no longer exists.

Decoherence is not the destruction of coherence.
It is **the completion of becoming**.

8. Mixed States and Partial Individuation

In the ED ontology, mixed states are not statistical artifacts or incomplete knowledge. They are the structural signature of **partial individuation**. A system becomes a fully distinct ED‑object only when it accumulates enough internal ED‑structure to support its own participation rule. But individuation is not binary. It is a gradient process. A system can possess some internal ED‑structure without possessing enough to behave independently.

This intermediate regime is what quantum mechanics calls a mixed state.

A partially individuated system has begun to develop its own ED-gradients, but the structure is incomplete. Some participation pathways are defined; others remain undeveloped. The system is neither fully sparse nor fully multiplicity-rich. It is a hybrid: a system that has started to become itself but has not yet finished becoming.

This explains the features of mixed states:

They exhibit reduced correlations.

- Because some participation pathways have individuated while others remain shared.

They are sensitive to environmental coupling.

- Because the remaining undeveloped gradients are easily overwhelmed by external ED-flow.

They retain vestiges of entanglement.

- Because the system has not fully differentiated from its partner.

They display entanglement entropy.

- Because the degree of individuation is measurable as the number of ED-gradients that have become distinct.

In ED, entanglement entropy is not an abstract information-theoretic quantity. It is a geometric measure of how much internal ED-structure a system has accumulated. A pure entangled state corresponds to zero individuation. A fully decohered state corresponds to complete individuation. Mixed states occupy the continuum between these extremes.

Quantum mechanics treats mixed states as epistemic or statistical.
ED treats them as **ontological**.

They are the structural record of a system that is in the process of becoming distinct but has not yet completed the transition. Partial individuation is not a flaw in the system. It is the natural intermediate stage between non-individuation and full identity.

Mixed states are the geometry of becoming, halfway formed.

9. Entanglement Swapping and Teleportation

In the ED ontology, entanglement swapping and teleportation are not mysterious transmissions of information. They are controlled manipulations of **participation rules** in systems that have not yet individuated. These processes appear exotic only because quantum mechanics lacks an ontology for identity formation. In ED, they follow directly from the structure of non-individuation.

9.1 Entanglement Swapping: Reassigning Undeveloped Identity

Entanglement swapping occurs when two non-individuated fragments are forced into new participation relationships through interaction with a third system. In ED terms, the process does not "transfer" entanglement. It **reassigns which fragments share the undeveloped participation rule**.

Because the fragments involved are still low-ED systems, their identities are not fixed. Their participation rules

can be reorganized without violating locality or causality. The universe is not transmitting correlations across space; it is simply updating which undeveloped ED-structures remain linked.

Swapping works because the systems involved have not yet become distinct.

9.2 Teleportation: Completing a Participation Rule Elsewhere
Quantum teleportation is often described as transmitting a state from one location to another. In ED, nothing is transmitted. Instead, teleportation is the process of **forcing individuation in one location while completing the same participation rule in another**.

The receiving system does not receive information. It completes the undeveloped participation rule that both systems inherited. The classical communication step is not a signal that "carries" the state; it is the final constraint that determines how the undeveloped rule must complete.

Teleportation works because the systems involved share a single undeveloped identity until the moment individuation is forced.

9.3 No Information Travels
In both entanglement swapping and teleportation:

- nothing moves between the systems
- no influence crosses space
- no hidden variables are exchanged
- no state is transmitted

The processes succeed because the systems involved **never possessed distinct identities to begin with**. They are not coordinating across distance; they are completing the same participation rule in different locations.

9.4 The Structural Principle
Entanglement swapping and teleportation are not quantum oddities. They are demonstrations of a deeper ED principle:
undeveloped identities can be reassigned, redirected, or completed anywhere because they are not yet individuated.

The universe is not performing magic.
It is honoring the structure of becoming.

10. Summary

In the ED ontology, entanglement is not a connection between distant systems, nor a nonlocal influence, nor a shared wavefunction stretched across space. It is the structural consequence of creating systems in a regime of **extremely sparse ED-gradients**, where individuation has not yet occurred. When a high-ED parent system splits into low-ED fragments, those fragments inherit a single undeveloped participation rule. They do not possess distinct identities because they lack the internal ED-structure required to support them.

Perfect correlations arise because the fragments are not yet different enough to disagree. Spatial separation is irrelevant because distance does not create individuation; only ED-development does. Measurement forces individuation by injecting ED and proliferating internal gradients. Decoherence is the environmental version of

the same process. Mixed states reflect partial individuation. Entanglement swapping and teleportation are controlled manipulations of undeveloped participation rules, not transmissions of information.

Entanglement, in ED, is not nonlocality.
It is **the persistence of undeveloped identity**.

The universe is not coordinating distant systems. It is allowing a single participation rule to complete itself in multiple locations until individuation forces it to fragment.
Entanglement is the geometry of becoming, before becoming has finished.