

Limits of a Theory of Everything: Resolution Boundaries, Observation, and the Nature of Time

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Abstract

Physics seeks to unify all fundamental forces and phenomena into a single Theory of Everything (ToE). This paper argues that the universe has a fundamental resolution boundary—an informational limit beyond which no resolution, or collapse of uncertainty, occurs. Since time emerges from such resolution events, no time exists beyond this boundary. This creates an absolute limit on unification and understanding, reframing the ToE problem as a bounded, rather than absolute, quest. The breakdown of classical space and time at fundamental scales is interpreted as the absence of observation, rather than a failure of concepts. The paper clarifies that while existence beyond the boundary may be possible, the lack of resolution there means no time or observable events are produced.

1. Introduction

Modern physics aims to develop a Theory of Everything that combines quantum mechanics, gravity, and other fundamental forces into a unified framework explaining all phenomena in the universe.

This pursuit assumes that the universe is fully unified and describable at all scales. Yet, conceptual advances in informational ontology and observation theory suggest a fundamental limit: a resolution boundary. This boundary restricts how finely information can be subdivided or resolved.

Observation, here understood as informational flow through structures culminating in a resolution event—a collapse of uncertainty—generates time itself. Beyond the resolution boundary, no such events occur; thus, no time is generated. This paper explores how these insights limit the scope of unification and change how we understand space, time, and the universe.

2. Observation as Informational Resolution

Observation is reframed as the flow of information through a structure, with a resolution event marking when uncertainty collapses into a stable form. In this framework:

The observer is any structure that allows information flow.

Observation requires no consciousness or mind; it is structural and functional.

Time is not a pre-existing background but the shape or structure left by the sequence of resolution events.

This means time arises from informational collapse—without resolution, no time exists.

3. The Resolution Boundary

The universe's resolution boundary is a fundamental informational limit where no further resolution or collapse occurs.

Physically, this might correspond to scales like the Planck length but more broadly represents an absolute informational threshold.

At this boundary:

No new resolution events happen.

No further subdivision of information is possible.

Consequently, no new moments, events, or time are created.

This boundary separates the universe as an informational system from anything "outside" it.

4. Clarifying Existence Beyond the Resolution Boundary

It is important to note that the resolution boundary does not imply that "nothing" exists beyond it. Rather, while something may indeed be present, this domain does not undergo informational resolution events—the collapse of uncertainty that defines observation and the creation of time.

In this informational framework:

Existence beyond the boundary is possible but not accompanied by resolution events.

Without resolution, no new moments, events, or time are generated in that domain.

This means the classical flow of time and observable phenomena are confined within the boundary, while something may still "be" beyond, though in a fundamentally different informational state.

This distinction preserves the ontological subtlety of the model, acknowledging that the absence of resolution does not equal absence of existence. It highlights that time and observable reality depend on resolution, not merely on presence.

5. Reinterpreting the Breakdown of Classical Space and Time

Physics often describes fundamental scales where classical concepts of space and time "break down." Traditionally, this means classical theories fail to apply or become inadequate.

From the informational perspective:

This breakdown is the absence of resolution or observational collapse at those scales.

Because time emerges only from resolution, no resolution means no time is generated and classical space-time does not exist there.

The “breakdown” is not a failure of concepts but a natural informational boundary marking where observation ceases.

Thus, classical space and time depend on ongoing informational resolution. Their absence signals a zone beyond observation.

6. Implications for the Theory of Everything

The quest for a ToE is limited by the resolution boundary:

Physical theories can describe all phenomena within this boundary.

Since no resolution and no time exist beyond, unification cannot extend past it.

The universe is therefore unified only within its informational domain, not absolutely with all possible realities.

This reframes the ToE as a bounded unification, constrained by ontological limits of observation and time generation.

7. Understanding Over Unification

Given these limits, understanding the universe means focusing on:

The structure and flow of information inside the resolution boundary.

The role of boundaries and resolution events in generating time and identity.

Accepting boundaries as fundamental features, not obstacles to be overcome.

This approach shifts the goal from absolute unification to rich comprehension of the universe’s informational processes.

8. Conclusion

The universe’s resolution boundary and the informational origin of time impose absolute limits on the Theory of Everything. Time and events arise only through resolution within this boundary, making unification inherently local and contextual.

Recognizing this boundary reframes physics’ quest: understanding the universe involves studying the nature and limits of informational resolution, accepting that “everything” is bounded by fundamental epistemic and ontological constraints.