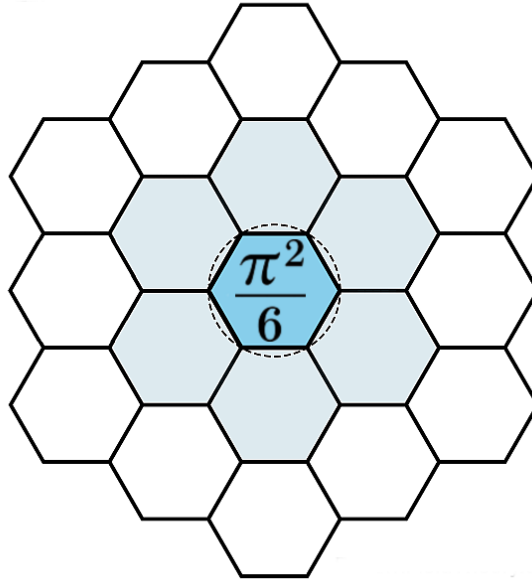# Causality, Correlation, and Structural Explanation

Expanded Depth Series: Paper 15

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Abstract

This paper reexamines causality and correlation within Pattern Field Theory as structural relations rather than temporal or dynamical processes. Causality is shown to arise from constraint dependency and accessibility, while correlation reflects shared structural support on the Allen Orbital Lattice.

Structural explanation is introduced as an alternative to causal narratives, grounding explanation in configuration geometry, Phase Alignment Lock, and basin structure rather than temporal succession or signal transmission.

$$\Psi_{n+1}(\omega') = \sum_{\omega \in \Omega} \mathbf{1}_{\text{PAL}(\omega \to \omega')} \, e^{i\theta(\omega,\omega')} \, \Psi_n(\omega)$$

All subsequent continuum equations arise as limits or projections of this operator.

1 Orientation and Dependency

This paper depends explicitly on the results of Papers 1 through 8 of the Expanded Depth Series.

Paper 8 established information, identity persistence, and observer patterns as structural properties of constraint geometry. The present paper explains how explanatory relations arise without temporal causation, how correlation emerges from shared structure, and how apparent causal narratives are recovered as projections of constraint dependency.

No time variable, force, or dynamical law is assumed. Explanation is treated as a structural relation, not a temporal story.

2 Structural Causality Without Temporal Order

In Pattern Field Theory, causality is not defined as influence propagating from past to future.

Definition 1 (Structural Causality)**.** *Structural causality is the dependency relation between configurations imposed by constraint accessibility and compatibility under PAL.*

A configuration is said to be causally prior to another if the latter cannot be realized without the former's constraint modifications. This relation does not require temporal ordering. It is defined entirely by structural dependency.

Structural causality therefore replaces cause–effect chains with accessibility graphs in configuration space.

Proposition 1. *All causal relations in Pattern Field Theory correspond to partial orders induced by constraint dependency.*

This formulation preserves explanatory power while eliminating temporal necessity.

3 Correlation as Shared Structural Support

Correlation does not imply causal influence. In Pattern Field Theory, correlation arises when multiple configurations depend on overlapping constraint structures.

Definition 2 (Structural Correlation)**.** *Structural correlation is the co-occurrence of configuration properties due to shared constraint geometry or basin structure.*

Configurations may be strongly correlated even when no causal dependency exists between them. Correlation reflects common support, not interaction.

This explains long-range correlations, symmetry-induced regularities, and apparent nonlocal effects without invoking signal transmission or hidden variables.

Correlation is therefore descriptive of structure, not evidence of causal action.

4 Constraint Dependency Graphs and Explanatory Order

Structural causality can be represented explicitly through dependency relations among PAL-compatible configurations.

Definition 3 (Constraint Dependency Graph)**.** *A constraint dependency graph is a directed acyclic graph whose nodes represent PAL-compatible configurations and whose edges encode necessary constraint dependencies.*

An edge from configuration A to configuration B exists if and only if B cannot be realized without prior modification of constraint geometry introduced by A. These graphs are acyclic because constraint loss and basin saturation eliminate circular accessibility.

Explanatory order is given by graph topology rather than temporal sequence. A configuration explains another when it occupies an upstream position in the dependency graph, regardless of apparent temporal ordering.

This provides a precise notion of explanation without invoking causes that act through time.

5 Recovery of Apparent Causal Narratives

Although causality is structural, human and experimental descriptions often employ temporal narratives.

These narratives arise when dependency graphs are projected onto coarse depth resolution, producing apparent sequences that resemble cause–effect chains.

Definition 4 (Apparent Causal Narrative)**.** *An apparent causal narrative is a linearization of a constraint dependency graph induced by coarse depth resolution and limited observational access.*

Different linearizations may be equally valid representations of the same underlying structure. This explains why distinct causal stories can fit the same data without contradiction.

Causal narratives are therefore interpretive overlays, not fundamental descriptions. Their utility lies in compression and communication, not ontological accuracy.

Lemma 1. *No apparent causal narrative uniquely determines the underlying constraint dependency graph.*

This resolves ambiguities in causal inference without appealing to hidden variables or indeterminism.

6 Structural Explanation and Scientific Inference

Structural explanation replaces causal explanation by grounding inference in configuration geometry and accessibility.

Definition 5 (Structural Explanation)**.** *A structural explanation accounts for an observed regularity by identifying the constraint geometry and dependency relations that make it unavoidable.*

In this framework, to explain a phenomenon is to show that no alternative PAL-compatible configurations are accessible under the given constraints. Explanation is therefore necessity-based rather than history-based.

Scientific inference proceeds by mapping observed regularities to invariant features of constraint geometry. Prediction corresponds to identifying future-accessible regions of configuration space under evolving structural constraints.

This approach unifies explanation, prediction, and correlation within a single non-temporal framework.

7   Summary of Structural Results

This paper has established the following results:

- Causality is redefined as structural dependency induced by constraint accessibility under Phase Alignment Lock.

- Correlation arises from shared constraint geometry and basin structure, not from causal influence or signal transmission.

- Constraint dependency graphs provide a precise, non-temporal account of explanatory order.

- Apparent causal narratives emerge as linear projections of dependency graphs under coarse depth resolution.

- Structural explanation accounts for regularities by demonstrating unavoidable configuration necessity.

Together, these results replace temporal cause–effect frameworks with a unified structural account of explanation, correlation, and inference.

8   Closure

Causality in Pattern Field Theory is not a force that acts through time. It is a relation of necessity embedded in constraint geometry.

Correlation does not demand explanation through hidden influences. It reflects shared structural support.

Explanation is not a story about what happened first. It is a demonstration of why alternatives are inaccessible.

With this paper, Pattern Field Theory completes its foundational account of causality and explanation without time, dynamics, or probabilistic assumptions, closing the explanatory layer of the theory.

Document Timestamp and Provenance

This document is part of Pattern Field Theory (PFT) and the Allen Orbital Lattice (AOL). It defines causality, correlation, and structural explanation as properties of constraint geometry used by subsequent papers in the Expanded Depth Series.