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\documentclass[12pt]{article}

\usepackage[margin=1in]{geometry}
\usepackage{setspace}
\usepackage{hyperref}

\setstretch{1.2}

\title{Guided Auxiliary Structure Discovery (GASD):\\
A Symmetry-Constrained Method for Latent Structure Inference Across Domains}

\author{Neil Clive Tuckwell}

\date{}

\begin{document}

\maketitle

\begin{abstract}
Across multiple scientific domains, recurring phenomena exhibit stable, coherent behavior that cannot be fully explained by explicitly stated boundary conditions alone. In such cases, explanation appears to require the introduction of latent structure or coupling. Without discipline, however, auxiliary constructs risk speculative inflation and loss of falsifiability. This paper introduces Guided Auxiliary Structure Discovery (GASD), a conservative, domain-agnostic methodological framework for admitting auxiliary structure only when strictly required. GASD formalizes dependency mismatch as a trigger for structural inference, employs bidirectional reasoning, constrains admissible constructs through symmetry preservation, and enforces explicit falsifiability and reversibility. This work advances no new empirical claims and is intended as a standalone methodological unifier for cross-domain research programs, including the Sympathetic Harmonic Resonance Framework (SHRF).
\end{abstract}

\section{Keywords}

guided inference; auxiliary structure; dependency mismatch; symmetry constraint; falsifiability; scientific methodology; cross-domain reasoning; SHRF

\section{Introduction}

Researchers across biology, materials science, fluid dynamics, and cosmology frequently encounter phenomena whose coherence, persistence, or stability exceeds what can be derived from stated boundary conditions alone. Historically, such situations have been handled either through ad hoc explanatory additions or through premature rejection of otherwise robust observations.
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Both responses are problematic. The former risks speculative overreach, while the latter risks discarding genuine structure. A disciplined method is therefore required to determine when the introduction of auxiliary structure is justified, and how such structure should be constrained, tested, and potentially removed.

Guided Auxiliary Structure Discovery (GASD) is proposed to address this recurring inferential problem.

\section{The Dependency Mismatch Principle}

GASD is activated by a specific condition termed a dependency mismatch.

\textbf{Definition (Dependency Mismatch).}
A dependency mismatch occurs when the explanatory resources required to account for an observed phenomenon exceed those present in the explicitly stated boundary conditions and known invariants.

If no dependency mismatch is present, no auxiliary structure is introduced. If a dependency mismatch is present, the existence of latent structure or coupling is implied, subject to strict constraints.

This principle serves as the sole license for structural augmentation within GASD.

\section{Forward Phase: Explanatory Sufficiency Scan}

The first phase of GASD proceeds forward from observation.

\subsection{Inputs}

\begin{itemize}
\item Observed behavior
\item Measured boundary conditions
\item Known invariants, such as conservation laws or symmetry relations
\end{itemize}

\subsection{Process}

Constraints are propagated forward to determine whether the observed behavior can be derived without additional structure. Points at which derivation stalls or becomes underdetermined are identified.

\subsection{Output}

The output of this phase is a dependency gap signature, describing what aspects of the phenomenon remain unexplained and why.

\section{Backward Phase: Minimal Structure Inference}

When a dependency mismatch is identified, GASD proceeds backward from the required explanatory closure.

The guiding question is as follows: what is the minimal additional structure that would render the observed behavior inevitable rather than accidental?

Permissible auxiliary constructs include, but are not limited to:
\begin{itemize}
\item latent resonant modes
\item coupling pathways
\item interface layers
\item coherence-mediating feedback structures
\end{itemize}

Auxiliary constructs are admitted provisionally and carry no presumption of permanence.

\section{The Four Admission Gates}

Every proposed auxiliary construct must pass all four admission gates. Failure at any gate results in rejection.

\subsection{Necessity}

The construct must directly eliminate the identified dependency mismatch.

\subsection{Minimality}

The construct must introduce the smallest possible increase in structural complexity sufficient to resolve the mismatch.

\subsection{Symmetry Preservation}

The construct must preserve known invariants and symmetries unless empirical evidence explicitly requires symmetry breaking.

\subsection{Falsifiability}

The construct must imply at least one measurable, testable prediction.

These gates ensure that intuition is disciplined rather than eliminated.

\section{Symmetry as a Search Constraint}

Within GASD, symmetry functions as a pruning mechanism rather than an aesthetic preference. Symmetry constraints reduce the space of admissible auxiliary structures and prevent redundant or non-identifiable explanations.

Common symmetry constraints include:

\begin{itemize}
\item scale coherence
\item surface-volume correspondence
\item resonance bandwidth conservation
\item energy-information duality
\item boundary-condition reciprocity
\end{itemize}

Symmetry violation is permitted only when empirically mandated.

\section{Iteration, Closure, and Reversibility}

GASD is explicitly iterative. Following admission of an auxiliary construct, predictions are generated and compared against observation. Constructs may be retained, refined, or removed.

No auxiliary structure is permanent by default. Reversibility is a core requirement of the method.

\section{What GASD Is Not}

GASD is not curve fitting, post hoc narrative construction, brute-force enumeration, or unconstrained speculation. It is a conservative method for managing explanatory necessity under uncertainty.

\section{Relationship to SHRF and Prior Work}

GASD serves as the methodological backbone for SHRF-based analyses across domains, including biological sensing surfaces, material persistence, fluid-mediated coherence, and large-scale astrophysical structure.

This paper does not advance new empirical claims. Its purpose is to stabilize and unify method.

\section{Limitations}

GASD does not guarantee correctness of auxiliary constructs, only disciplined admission. Incorrect constructs may pass initial gates and later be falsified. This is an intended feature of the method.

\section{Figure Description}

\textbf{Figure 1: Guided Auxiliary Structure Discovery Loop}

Observed Phenomenon ->
Boundary Conditions and Invariants ->
Forward Constraint Propagation ->
Dependency Mismatch Detection ->

Backward Minimal Structure Inference ->
Four-Gate Filter ->
Prediction Generation ->
Measurement and Comparison ->
Iteration or Closure

\section{Methods Consistency Statement}

All analyses referencing this work employ Guided Auxiliary Structure Discovery (GASD), introducing auxiliary constructs only when explanatory dependency exceeds stated boundary conditions, under strict necessity, minimality, symmetry, and falsifiability constraints.

\section{Conclusion}

Guided Auxiliary Structure Discovery provides a conservative, falsifiable, and symmetry-constrained method for introducing latent structure only when required. By formalizing a rule that is frequently applied implicitly across domains, GASD offers a unifying methodological foundation for cross-domain inference while preserving rigor and restraint.

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