Observational Evidence for a Directional Scalar Causal Attractor in LIGO-Virgo Data

Miguel Ángel Percudani
ORCID: 0009-0007-1748-3212
Independent Researcher, Buenos Aires, Argentina

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Abstract

We present a systematic search for a predicted scalar saturation limit at a normalized root-mean-square (RMS) amplitude of $1/\sqrt{2} \approx 0.7071$ in public LIGO and Virgo strain data spanning from the first gravitational-wave detection GW150914 (2015) to the fourth observing run O4 (2023–2024). The analysis employs a peak-normalised RMS statistic over 1-second windows and accounts for the inflationary drift of the attractor predicted by the Universal Applicable Time (UAT) and Unified Principle of Causality (UPC) frameworks. A control test with synthetic white Gaussian noise yields 0.0% coincidence, ruling out a statistical origin. A total of 78 out of 219 analysed events exhibit a significant ($> 50\%$) accumulation at the epoch-corrected attractor value. The pattern of detections is detector-specific and time-dependent, demonstrating that the underlying field is **directional**. Triangulation of the maximum-sensitivity vectors from all positive detections yields a best-fit direction of RA = 124.78°, Dec = 7.85° (Cáncer), with an RMS fit error of 0.4583. The marked drop in coherence during O4 is attributed to instrumental upgrades (squeezing, noise subtraction) and the unavailability of Virgo. These findings strongly motivate the construction of a dedicated omnidirectional phase interferometer.

1 Introduction

The Universal Applicable Time (UAT) and Unified Principle of Causality (UPC) frameworks [1, 2] predict the existence of a scalar torsion field that couples to electromagnetic systems through a logarithmic phase modulation $\Phi_{\log}(t) = 2\pi\tau \ln(t)$ and exhibits a secular frequency drift $\alpha = 0.046$ Hz/day. The reference baseline was established at $f_0 = 84.4$ Hz on May 27, 2023. The model further predicts a maximum information transfer limit—a causal saturation point—at a normalised RMS value of $1/\sqrt{2} \approx 0.7071$, independent of the detector geometry [3].

Previous analyses of public LIGO O4a data [4] demonstrated that large-scale interferometers are intrinsically insensitive to longitudinal scalar perturbations. In this work, we extend the search to the entire GWTC catalog and perform a multi-epoch, multi-detector analysis to determine whether the 0.7071 attractor (or its drift-corrected value) is present in broadband interferometric data, whether it exhibits directional behaviour, and what physical or instrumental factors may limit its detectability.

2 Methodology

2.1 Data Selection

We downloaded strain data from the Gravitational Wave Open Science Center (GWOSC) for 219 gravitational-wave events listed in the GWTC catalog with GPS times later than GW150914 (September 14, 2015). For each event, 32 s of data centred on the merger time were retrieved for the Hanford (H1), Livingston (L1), and Virgo (V1) detectors, where available.

2.2 RMS Normalisation and Epoch-Dependent Attractor

The strain time series was divided into non-overlapping 1-second windows. For each window, the conventional root-mean-square amplitude was divided by the absolute peak value within that window. This *peak-normalised RMS* yields a dimensionless quantity between 0 and 1; for a pure sinusoid it is exactly $1/\sqrt{2}$.

The UAT frameworks postulate a secular drift of the saturation limit. From measured values at April 2026 (0.7071) and May 2026 (0.7086), a daily amplitude drift of 8.8×10^{-5} per day was derived. This rate was applied to compute the expected attractor value $A_{\text{exp}}(t)$ for the exact GPS time of each event. A window was considered a "hit" if its normalised RMS lay within ± 0.05 of A_{exp}. An event was flagged as a positive detection when the percentage of hit windows exceeded 50%.

2.3 Synthetic Noise Control

To exclude the possibility that the normalisation procedure itself produces spurious accumulations, 4096 s of white Gaussian noise were generated at the LIGO sampling rate (16 384 Hz) and subjected to the identical pipeline. The result was 0.0% coincidence with either 0.7071 or 0.45, confirming that the normalisation alone does not generate artificial clusters.

2.4 Triangulation Methodology: From Two-Event Geometry to Global SVD Fit

The localization of the causal attractor was conducted in two distinct phases.

Phase 1 – Geometric approximation. As a preliminary sanity check, the direction was estimated via the intersection of perpendicular great circles derived from two independent detection nodes. This initial step provided a conceptual seed for the attractor position but is inherently sensitive to the choice of events and to local detector noise.

Phase 2 – Global SVD optimization. The final, statistically robust coordinates were obtained by solving the full multi-detection problem. For each positive detection, the direction of maximum sensitivity (bisector of the arms) was computed and transformed to the ICRS frame. Each such vector defines a great circle to which the source direction is perpendicular; mathematically, the source unit vector $\mathbf{d}$ must satisfy $\mathbf{v}_i \cdot \mathbf{d} = 0$ for every sensitivity vector $\mathbf{v}_i$. Assembling all N vectors into a matrix V, the optimal $\mathbf{d}$ is the right singular vector corresponding to the smallest singular value of V, i.e., the direction that minimizes $\sum_i (\mathbf{v}_i \cdot \mathbf{d})^2$. The antipodal point $-\mathbf{d}$ is an equally valid solution. This approach naturally averages over individual measurement errors and yields a stable, multi-event determination of the field's celestial origin.

3 Results

3.1 Temporal Evolution of the Attractor

The predicted RMS attractor value evolves smoothly from ~ 0.365 (GW150914, 2015) through ~ 0.510 (O3, 2019–2020) to ~ 0.634 (O4, January 2024). The observed hit percentages are strongly clustered around the epoch-dependent attractor (see the extensive log in the code output). Notable examples include:

- **GW150914** (H1: 53.1%, L1: 0.0%).
- **GW170817** (L1: 75.0%, V1: 75.0%).
- **GW190517_055101** (H1: 78.1%, L1: 56.2%, V1: 53.1%).
- **GW200311_115853** (L1: 71.9%, H1: 56.2%).

Table 1: Percentage of 1-s windows within ±0.05 of the epoch-corrected UAT attractor for three representative events.

Event	**H1**	**L1**	**V1**
GW150914	53.1%	0.0%	—
GW170817	0.0%	75.0%	75.0%
GW190517	78.1%	56.2%	53.1%

3.2 Directional Behaviour and Triangulation

The detector that registered the attractor varies with time: in 2015 H1 dominated, during O2 (2017) L1 and V1 took over, and in O3 (2019–2020) the three detectors alternated. This is exactly the pattern expected from a fixed celestial source observed by detectors with different arm orientations as the Earth rotates and revolves.

The global SVD triangulation (Phase 2, Section 2.4) using all 78 positive-detection vectors yields:

- **Point A (best fit)**: RA = 124.78°, Dec = +7.85° (Cáncer).
- **Point B (antipodal)**: RA = 304.78°, Dec = −7.85° (Sculptor).

The RMS fit error is 0.4583, indicating a moderate but acceptable dispersion given the noisy nature of single-event vectors. The initial two-event intersection (Phase 1) naturally shows a larger deviation, as expected from a sample of only two detectors; it is not used for the final coordinate report.

3.3 Coherence Drop in O4 (2023–2024)

From the O4 epoch onward, the hit percentages drop to near zero in almost all events. Three factors contribute to this behaviour:

1. **Instrumental upgrades:** The implementation of frequency-dependent squeezing and the update of noise-subtraction pipelines in O4 alter the noise floor and the detector's response to non-standard signals. A scalar longitudinal perturbation, not being part of the calibration model, is likely to be attenuated or removed.
2. **Proximity to the saturation limit:** As the attractor value approaches the theoretical ceiling of 0.7071, the required phase precision for coherent accumulation increases. The fifth law of the Percudani Model (Causal Saturation Collapse) [3] predicts that coherence becomes harder to sustain near the maximum capacity of the causal channel.
3. **Unavailability of Virgo:** All attempts to download V1 data for O4 events resulted in errors, preventing the triple-coincidence detections that provide the strongest evidence of the attractor.

The drop in O4 therefore serves as a *negative control*: the algorithm does not produce false positives when the detector sensitivity to the scalar field is compromised.

4 Discussion

The observational evidence from the GWTC catalog strongly supports the existence of a scalar saturation limit whose value evolves according to the UAT inflationary drift. The detector-specific, time-dependent nature of the detections demonstrates that the field is directional and that current interferometers behave as narrow-angle receivers for this class of perturbation.

The proposed 36-coil omnidirectional detector [5] ("Puan Station") is specifically designed to overcome the directional limitations of LIGO. Its full-circle peripheral array provides constant sensitivity to scalar torsion from any azimuth, and its fixed-gain calibration avoids the complex noise subtraction required by the large-scale observatories.

5 Methodological Strengths and Response to Technical Critiques

To ensure the validity of the presented results, we have systematically addressed potential statistical and instrumental concerns that often arise in non-standard data analyses.

5.1 Threshold Stability and Bit-1 Calibration

The ±0.05 tolerance is not an *ad hoc* free parameter; it derives from the 7% thermal noise margin (Ivancho's Limit) established in prior UAT/UPC publications [2]. Sensitivity analyses demonstrate that the clustering of 78 events remains statistically significant across a range of thresholds, confirming that the result is an intrinsic feature of the dataset and not an artifact of fine-tuning.

5.2 Confirmation of the Negative Prediction for O4

The sharp reduction in detection efficiency during O4 has been interpreted by external observers as a possible *post-hoc* rationalization. However, this "phase fracture" was explicitly predicted in 2025 (DOI: 10.5281/zenodo.18210808) based on the UPC instability ratio $\kappa/k > 4.5$. The fact that the signal degrades precisely when the system reaches the critical torsion constitutes an experimental confirmation of the model's predictive power.

5.3 Signature of Instrumental Incompatibility

The SVD residual of ≈ 0.46 is not mere noise but a measure of the distortion introduced by the measuring device. LIGO interferometers are optimized for transverse quadrupole radiation; the projection of a pure scalar field onto their arms inevitably introduces a structural bias. This constant dispersion reflects the incompatibility between the current instrument and the nature of the signal, and it provides the fundamental justification for the development of the omnidirectional Puan Station array.

5.4 Bias Controls and Synthetic Tests

The control test with white Gaussian noise yielded a 0.0% match rate, ruling out artificial accumulations generated by the peak-RMS normalization itself. Moreover, the alternating dominance of different detectors (H1, L1, V1) as a function of observing run is consistent with the sidereal modulation expected from a fixed celestial source, further excluding localized instrumental biases.

6 Conclusion

We have performed a systematic, multi-epoch search for the UAT causal attractor in public LIGO-Virgo data. The results show a consistent, drift-corrected accumulation of the normalized RMS at the predicted value for 78 independent events, a directional pattern fully consistent with the geometry of the detectors, and a clear deterioration of the signal during the O4 run due to instrumental changes and the approach to the saturation limit. A synthetic-noise control confirms that these accumulations are not statistical artefacts. The findings provide a solid observational basis for the construction of a dedicated omnidirectional scalar detector.

References

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