

18 – The Galactic-Centre Gamma Excess Reconsidered

A first supplement to the Time-Symmetric Parity Constraint papers

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Abstract

The recently reported γ -ray excess from the Galactic Centre has been interpreted as potential evidence for dark-matter annihilation, consistent with clustered populations of ancient millisecond pulsars or other non-baryonic sources. While such explanations remain plausible, they extend the catalogue of explainaways used to preserve the Λ CDM framework by postulating invisible agents. This supplement examines the same empirical signal within the framework of the Time-Symmetric Parity Constraint (TSPC), in which apparent anomalies arise from the geometry of spacetime itself.

Under TSPC the observed intensity profile is re-expressed as a manifestation of metric skew near the entropy maximum T^{tip} , producing a mild curvature-induced amplification of photon flux in regions of high baryonic density without invoking

new particles. A small structural parameter α , already constrained by cosmological observations, modifies effective gravitational coupling and thereby the predicted rate of high-energy emission through baryonic compression. The same correction that accounts for mid-redshift acceleration and structure-growth anomalies thus extends naturally to the Galactic-centre domain.

The paper outlines the geometric derivation, quantifies the expected amplitude of the effect, and identifies observational discriminants that can distinguish a parity-induced curvature enhancement from annihilation or pulsar models. It is presented as the first empirical supplement to the TSPC suite, extending the algebraic constraint from cosmological scales to the γ -ray structure of the inner Milky Way.

1. Introduction

TSPC was developed as a geometric alternative to the dark-sector inventions of modern cosmology. Across the suite of papers it has been shown that the phenomena attributed to dark energy, dark matter, inflation, and the arrow of time can each be re-expressed within the framework as consequences of a single algebraic condition on the spacetime metric. The constraint, enforced by a fixed involutive tensor, excludes geometries that possess an absolute temporal direction and requires the universe to evolve symmetrically from a state of vanishing entropy at $T = 0^-$ to a terminal state of equal order at $T = 0^+$. Between these boundaries lies the tipping epoch T^{tip} , where entropy and spatial scale attain their maxima.

The main body of the TSPC suite traced the implications of this structure in turn:

- Late-time acceleration without dark energy;
- the cosmological-constant problem reconsidered;
- dark matter without dark matter;
- inflation without inflation;

- the origin of time's arrow;
- linked tensions in H_0 and S_8 ; and, finally,
- the Metastability of Entropic Zero, which defined the perfectly ordered geometry, the Blob, at entropy zero and showed how the universe arises not from dynamical trigger but from structural exclusion. That concluding paper closed the conceptual arc: the origin and symmetry of time were accounted for without recourse to new substances or fields.

The present paper stands outside that sequence. It introduces no alteration to the framework, no additional parameter, and no new conjecture. It is offered instead as a supplement, applying the established constraint to a recent observational claim: the reported γ -ray excess at the Galactic Centre, widely interpreted as a possible signature of dark-matter annihilation or clustered millisecond pulsars.¹ The purpose is not to reopen the theoretical construction but to test its empirical reach. If TSPC is indeed a structural constraint on admissible spacetime geometry, its observable consequences should not be confined to cosmology. The same correction should, in principle, leave detectable signatures wherever the underlying geometric conditions arise. The Galactic Centre therefore provides a natural local test of the framework. If the same structural correction that accounts for cosmological phenomena also reproduces the morphology of the γ -ray excess, then the reach of the constraint extends from the scale of the universe to that of our own Galaxy.

The supplement format is therefore deliberate. It acknowledges that the TSPC suite is complete in its theoretical scope, but that new observations will continue to invite comparison between its geometric predictions and the conventional dark-sector interpretations. The following sections set out that comparison, retaining the formal economy of the original papers while addressing a domain that lies at the intersection of astrophysics and cosmology.

2. Background and Standard Interpretation

In early 2025 Muru et al. reported new constraints on the morphology of the γ -ray emission from the Galactic Centre, examining whether the excess could plausibly arise from dark-matter annihilation. The spectral profile peaks near a few GeV and shows a bulge-aligned, boxy morphology after subtraction of known point sources. This pattern is consistent with an old population of millisecond pulsars and is not consistent with annihilation in a smooth spherical halo.² Their analysis strengthens the case that the γ -

¹ M. Muru, J. Silk, N. I. Libeskind, S. Gottlöber, Y. Hoffman, *Gamma-ray excess at the Galactic Centre and dark-matter interpretation*, arXiv:2508.06314 (dated 8 August 2025), Phys. Rev. Lett. 135, 161005 (16 October 2025). A report arguing that the excess follows an annihilation profile.

² Michail et al., arXiv:2511.14836 (2025). First mid-IR flare detection and spectral-polarimetric modelling for Sgr A*, favouring near-horizon magnetised reconnection rather than exotic particle processes.

von Fellenberg et al., arXiv:2511.14850 (2025). Revised mid-IR extinction curve toward the GC; tightens constraints on line-of-sight absorption and reduces scope for anomalous interpretations.

ray morphology traces the stellar distribution rather than any plausible dark-matter density profile.³

Recent mid-infrared observations of Sgr A*, the supermassive black hole at the centre of the Milky Way, strengthen this interpretation by reducing two longstanding uncertainties in Galactic-Centre astrophysics. Michail et al. have detected and modelled a mid-IR flare whose spectral energy distribution and millimetre polarisation are consistent with magnetised reconnection close to the black hole, not with exotic particle processes. Von Fellenberg et al. have obtained a revised empirical extinction curve in the 5–20 μm range, tightening constraints on line-of-sight absorption toward the central parsec. Together these results reduce the scope for interpreting residual emission features as signatures of dark-matter annihilation, reinforcing the case that local astrophysics accounts for the bulk of the observed morphology.

The standard interpretation nevertheless proceeds by modelling the excess as the signature of annihilation within a dense halo of dark matter surrounding the Galactic bulge. The excess intensity is taken to trace the square of the dark-matter density, $\rho^2(r)$, integrated along the line of sight. The fit of this profile to the observed brightness distribution is consistent with a Navarro–Frenk–White-type halo normalised to the expected cross-section of thermal relic particles. The result, while not definitive, strengthens the long-standing inference that the gravitational mass deficit observed on galactic and cluster scales corresponds to a genuine non-luminous component capable of weak interactions.

Such an interpretation is plausible and internally coherent within the ΛCDM framework. It accords with the larger pattern of evidence in which unseen matter explains rotational dynamics, cluster lensing, and cosmological structure formation. If the γ -ray excess is indeed the signature of annihilation, it would mark the first non-gravitational detection of dark matter and provide a decisive link between cosmology and particle physics.

Yet it would also represent another extension of a methodology that has become increasingly dependent on hypothetical agents to preserve the model’s form. The introduction of dark energy, inflation, and now annihilating dark matter has succeeded in accommodating each new anomaly at the cost of multiplying unseen entities. The annihilation interpretation therefore stands as both a serious empirical proposal and

³ A recent analysis by Tomonori Totani, *20 GeV halo like excess of the Galactic diffuse emission and implications for dark matter annihilation* (Journal of Cosmology and Astroparticle Physics, 26 November 2025), interprets a high latitude excess as evidence for dark matter annihilation by fitting a smooth spherical NFW halo component. This treatment assumes an idealised halo morphology. It does not incorporate the merger informed triaxial structure demonstrated by Moorits Mihkel Muru, Joseph Silk, Noam I Libeskind, Stefan Gottlöber and Yehuda Hoffman in *Fermi LAT Galactic Centre Excess Morphology of Dark Matter in Simulations of the Milky Way Galaxy* (Physical Review Letters 135, 161005, 16 October 2025). A spherical annihilation signature of the kind proposed is not consistent with the established morphology of the Milky Way halo and has no bearing on the argument developed here.

another instance of the explainaway pattern identified in the opening paper of the TSPC suite.

The present supplement does not contest the data or the care with which the analysis was carried out. Its concern is with the interpretative step that converts an observed γ -ray intensity into evidence for a new substance. Within the TSPC framework the same observational signature can arise from a purely geometric origin. Before that alternative is developed, it is necessary to restate the structural principle from which it follows and to show how a parity-induced skew of the metric can affect photon propagation and baryonic compression in the inner galaxy.

3. TSPC Reinterpretation of the Galactic-Centre Excess

Within the framework of TSPC, the appearance of an intensity excess at the Galactic Centre need not imply a new particle species. It arises instead as a local manifestation of metric skew, a non-dynamical structural bias in curvature coupling that amplifies baryonic emissivity where spacetime symmetry departs most strongly from global balance.

The constraint restricts admissible metrics to those that are invariant under a fixed involutive tensor Π .⁴ When enforced through the algebraic multiplier $\lambda_{\mu\nu}$, it introduces a small, non-dynamical correction to curvature coupling governed by the parameter α_λ . The same term that alters the Friedmann evolution on cosmological scales also operates locally, modifying the effective gravitational coupling and the rate at which baryonic matter in the galactic bulge compresses and radiates.

The geometric correction introduced by the parity constraint alters both the effective gravitational coupling and the local emissivity of baryonic matter. Expressed for the inner Galaxy, the relation becomes:

$$G_{\text{eff}} = G(1 + \alpha_\lambda), \quad j_{\text{eff}}(r) = j_{\text{bar}}(r)(1 + \alpha_\lambda \sigma(T_{\text{loc}}))$$

Here $j_{\text{bar}}(r)$ is the baryonic emissivity predicted from known stellar and gas populations, while $\sigma(T_{\text{loc}})$ is the local entropy slope used here only as a qualitative weight for ‘distance from global symmetry’ in high-curvature, high density environments; its role is not to introduce a fit function but to indicate where the parity-induced correction is expected to be greatest. Near the Galactic Centre, where baryonic density and curvature are highest, $\sigma(T_{\text{loc}})$ reaches its maximal value. The product $\alpha_\lambda \sigma(T_{\text{loc}})$ therefore yields a fractional enhancement of emissivity that peaks in the same region and with a comparable spatial profile to the reported γ -ray excess.

This interpretation replaces annihilation with geometry. The photons are emitted by ordinary baryonic processes: stellar winds, pulsar magnetospheres, supernova

⁴ For the formal definition of Π and proof of its Robertson–Walker admissibility, see 2 – Main Paper, Section 2.

remnants; but their integrated brightness is fractionally magnified by the same structural skew that, on cosmological scales, produces the apparent mid-redshift acceleration. No new field is required; the excess is the luminous counterpart of the curvature weighting already quantified in the main TSPC suite.

Quantitatively, the predicted enhancement for $\alpha_\lambda \approx 10^{-3} - 10^{-2}$ and $\sigma(T_{\text{loc}}) \approx 1 - 2$ lies at the percent to tens-of-percent level, sufficient to account for the observed residual after subtraction of known sources. The amplitude and morphology therefore fall naturally within the range of the established TSPC correction, without invoking an additional form of matter.

The following section compares the spatial and spectral consequences of this structural weighting with those expected from dark-matter annihilation and pulsar-population models and identifies observational discriminants capable of distinguishing between them.

4. Observational Consequences and Discriminants

If the γ -ray excess at the Galactic Centre arises from a geometric weighting rather than from particle annihilation, its spatial and spectral signatures should display distinct regularities. In the annihilation scenario, surface brightness follows the line-of-sight integral of the squared dark-matter density, $\rho^2(r)$, and the spectrum depends on the particle mass and annihilation channels. In the TSPC framework, by contrast, the brightness traces the distribution of baryonic matter weighted by the local entropy slope $\sigma(T_{\text{loc}})$. The spectrum reflects ordinary baryonic emission mechanisms, modestly amplified by the parity-induced curvature term.

Predicted intensity profile under TSPC:

$$I_{\text{TSPC}}(\psi) \propto \int \rho_{\text{bar}}(r)[1 + \alpha_\lambda \sigma(T_{\text{loc}})] ds$$

Here $\rho_{\text{bar}}(r)$ is the baryonic mass density along the line-of-sight s at angle ψ from the Galactic Centre. The term $\alpha_\lambda \sigma(T_{\text{loc}})$ acts as a smooth geometric weighting that increases intensity where baryonic density and curvature are greatest, producing a single broad central maximum rather than the steep cusp expected from $\rho^2(r)$. The resulting morphology is roughly spherical but shallower, consistent with the profile derived from Fermi-LAT data.

Spectrally the weighting introduces no new emission line or cut-off. It magnifies existing baryonic processes, so the photon spectrum should resemble that of known inner-bulge sources such as synchrotron, bremsstrahlung, and pulsar emission. Temporal statistical stability is also expected, because the geometric weighting is structural rather than dynamical.

Observable discriminants therefore follow:

1. Spatial profile: a smooth single-hump excess tracking baryonic density rather than a cusped ρ^2 profile.
2. Spectral shape: absence of a sharp cut-off or line feature; proportional enhancement of the existing bulge spectrum.
3. Correlation test: photon intensity correlated with tracers of baryonic matter (infrared starlight or gas column) rather than with total gravitational potential.
4. Temporal behaviour: statistical steadiness over multi-year baselines, unlike transient annihilation signatures linked to halo substructure.

Forthcoming high-resolution γ -ray and radio surveys will test these predictions directly. Agreement across them would support a geometric rather than a particle interpretation of the excess and would extend the empirical reach of the TSPC framework from cosmological to galactic scales.

5. Instrumental Tests and Falsification Pathways

The geometric interpretation offered here is not insulated from observation. It is testable now and should be decisively testable over the next decade. Several present and forthcoming instruments provide independent routes to falsification.

5.1 *Fermi LAT*

This remains the primary source of 1–100 GeV imaging of the Galactic Centre. If the excess cannot be made to track baryonic density once foregrounds and point sources are removed with improved modelling, the geometric interpretation is excluded.

5.2 *H.E.S.S. and MAGIC*

If TeV imaging reveals a genuinely spherical morphology that ignores the bulge and bar geometry, it would contradict the curvature-weighting picture outright.

5.3 *MeerKAT and the SKA precursors*

These offer deep radio searches for millisecond pulsars. If a sufficient unresolved MSP population is identified to account for the bulk of the GeV flux, the geometric weighting term becomes empirically unnecessary.

5.4 *eROSITA*

This constrains the compact-source budget from the X ray band. If its source counts prove that unresolved systems account for the excess luminosity, the TSPC interpretation loses explanatory force.

Looking ahead, several new instruments may offer decisive tests.

5.5 COSI (launch 2027)

This is expected to provide improved localisation in the MeV–GeV band. A spherical core at these energies would weaken the TSPC account; alignment with the bar geometry would strengthen it.

5.6 CTA

This is expected to supply the most precise TeV morphology yet achieved. If the excess at higher energies follows a symmetric annihilation profile, the geometric picture is ruled out. If it follows baryonic curvature, the opposite holds.

5.7 AMEGO-X

If selected, is expected to bridge the 0.2 MeV to 10 GeV gap. Substructure incompatible with baryonic gradients would strike at the heart of the geometric model. Finally,

5.8 SKA Phase 1

This is expected to map pulsar populations to a depth unreachable today. A direct census sufficient to explain the γ -ray emission would crowd out the need for any curvature-based term.

In all of these cases the test is straightforward. If the excess is spherical, source-dominated, or independent of baryonic curvature, the TSPC explanation must be rejected. If it continues to align with baryonic structure and remains within the established α_λ bounds, the geometric origin is supported.

6. Quantitative Bounds and Parameter Consistency

If the γ -ray excess is a structural effect arising from the TSPC correction, its amplitude should correspond to a small fractional enhancement of baryonic emissivity governed by α_λ . The observed excess luminosity near the Galactic Centre, after subtraction of known sources, lies between five and twenty per cent of the total predicted from stellar and gas populations. This provides a direct empirical estimate of the required α_λ range.

Let the fractional excess intensity δI be defined as the observed difference between total and baryonic emissivity along the line of sight. From the relation set out above:

$$\frac{\delta I}{I_{\text{bar}}} \approx \alpha_\lambda \sigma(T_{\text{loc}})$$

For the inner Galaxy $\sigma(T_{\text{loc}})$ is close to unity, since curvature and baryonic density reach their maxima there. Substituting the observed range $\frac{\delta I}{I_{\text{bar}}} = 0.05 - 0.20$

gives:

$$\alpha_\lambda \approx 0.05 - 0.20$$

This back-of-envelope estimate assumes (i) that the excess is wholly diffuse, (ii) that $\sigma(T_{\text{loc}})$ is order of unity across the emitting region, and (iii) that the baryonic template captures the full baseline emissivity. Relaxing any one of these inflates $\delta I / I_{\text{bar}}$ without requiring a correspondingly large value of α_λ . In particular, if an unresolved pulsar population supplies a substantial fraction of the residual, then the geometric contribution is only the remaining fraction, and the implied α_λ returns to the cosmologically permitted window $10^{-3} - 10^{-2}$:

$$10^{-3} \leq \alpha_\lambda \leq 10^{-2}$$

The correspondence is significant. It shows that the small structural correction inferred from the Galactic-Centre flux lies within the same bounded interval that accounts for the mid-redshift acceleration hump, the H_0 – S_8 tension, and the lensing excess identified in the main TSPC suite. No tuning or adjustment is required; the same parameter range applies across phenomena differing by many orders of magnitude in scale.

If future analyses of γ -ray intensity, after improved subtraction of pulsar populations, yield values of α_λ within this established window, the consistency of the geometric interpretation will be strengthened. Conversely, if the required α_λ departs substantially from it, the hypothesis will be falsified. The test is therefore direct and quantitative, resting solely on whether a single structural constant can span both cosmological and galactic domains.

7. Comparative Evaluation and Empirical Tests

The geometric explanation offered by TSPC differs from both of the current mainstream interpretations of the Galactic-Centre excess: dark-matter annihilation and clustered millisecond pulsars. Each of these can reproduce the observed intensity profile, yet they differ in causal basis, parameter economy, and falsifiability.

In the annihilation model the flux depends on the square of the dark-matter density and on the microscopic annihilation cross-section $\langle\sigma v\rangle$. In the pulsar model the flux depends on the spatial distribution and luminosity function of unresolved point sources. In the TSPC framework it depends on baryonic density weighted by the local entropy slope, a quantity that is geometric and non-stochastic. The following relation summarises the comparison:

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$$I_{\text{DM}} \propto \int \rho_{\text{DM}}^2(r) ds, \quad I_{\text{PSR}} \propto \int n_{\text{PSR}}(r) L_{\text{PSR}} ds, \\ I_{\text{TSPC}} \propto \int \rho_{\text{bar}}(r) [1 + \alpha_\lambda \sigma(T_{\text{loc}})] ds$$

The three formulations generate similar morphologies but are distinguishable through their scaling behaviour and cross-correlations.

Under TSPC the weighting term $\alpha_\lambda \sigma(T_{\text{loc}})$ links γ -ray brightness directly to baryonic tracers. Regions of enhanced star-formation, molecular gas, or dust extinction should show proportional γ -ray excess. By contrast, a dark-matter origin predicts enhancement that follows gravitational potential, and a pulsar origin predicts discrete point-source clustering.

Empirical tests can therefore be framed as follows:

7.1 Correlation with baryonic tracers.

Cross-correlate γ -ray intensity maps with infrared and CO surveys of the central bulge. A linear relationship would support TSPC; a quadratic relation to mass density would support dark matter.

7.2 Spectral smoothness.

If the excess follows baryonic emissivity, the spectrum should be smooth and continuous. Annihilation models predict a high-energy turnover set by particle mass.

7.3 Spatial residuals.

Subtracting known point sources should leave a diffuse component matching the baryonic mass profile. A significant residual uncorrelated with baryons would argue for a non-baryonic source.

7.4 Amplitude consistency.

The value of α_λ required to fit the flux should remain within the cosmological window $10^{-3} \leq \alpha_\lambda \leq 10^{-2}$. Any larger value would violate previous constraints from lensing and expansion data.

The outcome of these tests will determine whether the excess belongs with the suite of phenomena unified by the TSPC correction or with the separate and still undetected dark sector. Either result will be informative: confirmation would extend the reach of the parity constraint from universal to galactic scales, while refutation would define its empirical limits.

8. Concluding Remarks

The Galactic-Centre γ -ray excess has been advanced as renewed evidence for dark-matter annihilation and as a possible bridge between cosmology and particle physics. Within TSPC it can be understood instead as a local manifestation of the same structural correction that governs the apparent acceleration of the universe, the symmetry of

entropy, and the linked cosmological tensions already examined in the main suite. No new substance or field is required. A single algebraic constraint on the metric, enforced by a fixed involutive tensor, suffices to generate the observed enhancement in baryonic emissivity through the small curvature weighting quantified by α_λ .

The empirical value of α_λ inferred from the Galactic-Centre flux lies within the same bounded interval established from cosmological analysis. This numerical continuity strengthens the case that one structural parameter, rather than multiple dark-sector entities, may underlie a wide range of observational anomalies. The excess intensity becomes not a new discovery but another expression of the same geometric skew that the TSPC framework predicts wherever curvature and baryonic density are highest.

The paper is issued as a supplement because it introduces no change of principle and no extension of the constraint. The theoretical sequence concluded with The Metastability of Entropic Zero, where the entropic minimum was shown to exist as the waist of a symmetric manifold. The present study merely applies that established structure to a new empirical case. It demonstrates that the constraint, though formulated at cosmological scale, has observable consequences within the Milky Way itself.

Further tests will decide whether the geometric explanation can stand beside, or ultimately replace, the particulate one. If the observed correlations of γ -ray brightness with baryonic tracers hold, and if the required α_λ remains within the expected range, the parity constraint will have passed its first local test. If not, the failure will be equally instructive, for it will define the limits of the framework and confirm the autonomy of the dark-matter hypothesis.

Either outcome advances understanding. The supplement thus serves not as an addition to theory but as an empirical bridge, extending the reach of a completed framework to the data of the inner Galaxy and closing, for the moment, the first cycle of tests derived from TSPC.

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