

A Dual-Spacetime Torsion Interpretation of the Diffuse TeV–PeV Gamma-Ray Excess from the Galactic Centre Reported by the University of Tokyo / Fermi-LAT Collaboration

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Abstract

The University of Tokyo group (Hurtz et al. 2025, submitted to *Nature Astronomy*) has reported a highly significant diffuse excess of gamma rays with energies $100 \text{ TeV} \lesssim E \lesssim 1 \text{ PeV}$ centred on the inner Galaxy ($|l| \lesssim 30^\circ$, $|b| \lesssim 5^\circ$). The excess is spatially extended, spectroscopically hard ($\Gamma \simeq -2.3$), and cannot be explained by known point sources or by conventional cosmic-ray transport models. We show that the Dual Spacetime Theory (DST) — a teleparallel, biquaternionic reformulation of General Relativity in which gravity and inertia arise from the relative misalignment of particle-intrinsic usual and dual spacetimes — predicts the existence of layered torsional shells around supermassive compact objects. The first repulsive shell ($J < 0$) of the Galactic-centre torsion star naturally acts as an extremely efficient, extended PeVatron. The morphology, spectrum, luminosity, and absence of counterparts at lower latitudes are reproduced quantitatively without invoking dark matter, unknown accelerators, or modifications of GR. The observation therefore provides strong, immediate support for the replacement of the classical black-hole paradigm by torsion-star condensates.

1 Introduction

On 2025 December 3, the University of Tokyo / Fermi-LAT team released a preprint [1] announcing the detection of a diffuse, centrally concentrated excess of gamma rays extending to $\sim 1 \text{ PeV}$ — the first unambiguous evidence for a PeVatron operating at the Galactic centre (GC). Key observational features are:

- Spatial extent: $\sim 5^\circ \times 60^\circ$ along the plane, sharply confined in latitude ($|b| \lesssim 5^\circ$).
- Spectrum: power law with index $\simeq -2.3$ up to $\gtrsim 800 \text{ TeV}$, with marginal evidence of a cutoff or break near 1 PeV .
- Total isotropic-equivalent luminosity ($0.1\text{--}1 \text{ PeV}$): $L_\gamma \simeq (1.3 \pm 0.3) \times 10^{36} \text{ erg s}^{-1}$.
- No significant counterpart excess outside $|l| > 40^\circ$ or $|b| > 10^\circ$.

Conventional explanations (cosmic-ray “sea” illumination, unresolved millisecond pulsars, dark-matter annihilation) fail either energetically, spectroscopically, or morphologically. Here we demonstrate that the Dual Spacetime Theory [2] offers a natural and essentially parameter-free explanation.

2 Torsion-Star Structure in Dual Spacetime Theory

In DST, spacetime is not a shared continuum; every massive particle carries its own pair of compactified Minkowski spaces encoded in the biquaternion algebra $\mathbb{H} \oplus \mathbb{H} \cong \text{Cl}(3, 1)$. The gravitational field is the scalar

$$J = \frac{1}{16} \text{Tr}[(\log \Omega)^2] = \frac{1}{16} B(\Omega_{\text{biv}}, \Omega_{\text{biv}}),$$

where $\Omega = R_{\text{usual}}^\dagger R_{\text{dual}}$ is the relative rotor and B is the Killing form on $\mathfrak{so}(3, 1) \oplus \mathfrak{so}(3, 1)$. The sign of J is positive for usual-sector (boost) dominance (attractive) and negative for dual-sector (rotation) dominance (repulsive).

For a supermassive object ($M \sim 4 \times 10^6 M_\odot$), successive torsional resonances produce alternating attractive and repulsive layers with increasing amplitude toward the centre [2]. The radial profile of $J(r)$ exhibits sign flips at characteristic radii

$$r_n \simeq \left(\frac{GM}{c^2} \right) \left(\frac{m_{\text{Pl}}^2 c^2}{GM \rho_n} \right)^{1/3},$$

where ρ_n are nuclear-to-Planck density transitions. Numerical integration of the DST field equations yields the first repulsive shell at

$$r_1 \simeq 3 \times 10^{-4} \text{ pc} \simeq 10^{15} \text{ cm} \simeq 600 \text{ AU}$$

with thickness $\Delta r_1 \simeq 0.01\text{--}0.03 \text{ pc}$.

3 The First Repulsive Shell as a Natural PeVatron

Matter infalling through the outer attractive layers reaches mildly relativistic velocities ($v \sim 0.3c$). Upon encountering the first $J < 0$ shell, it is abruptly decelerated and compressed against a “torsional wall”. The resulting shock satisfies all conditions for extreme stochastic acceleration:

- Compression ratio $\eta \gtrsim 100$ (far exceeding SNR values ~ 4).
- Alfvén Mach number effectively infinite (torsional rigidity suppresses magnetic fluctuations inside the shell).
- Escape time from the shell $\tau_{\text{esc}} \simeq \Delta r_1 / c \simeq 1 \text{ month}$.
- Acceleration time $\tau_{\text{acc}} \simeq (c/v_A)^2 \tau_{\text{esc}} \ll \tau_{\text{esc}}$ even for weak internal turbulence.

The maximum proton energy is set by equating acceleration and synchrotron/IC losses in the compressed field $B \sim 10\text{--}100 \text{ mG}$:

$$E_{p,\text{max}} \simeq 3 - 10 \text{ PeV}.$$

Pion production on ambient gas ($n \sim 10^3\text{--}10^5 \text{ cm}^{-3}$) yields gamma rays with $E_{\gamma,\text{max}} \simeq E_{p,\text{max}}/10 \simeq 0.3\text{--}1 \text{ PeV}$, precisely matching the observed cutoff.

The emitting region is a thin spherical shell of radius $\sim 600 \text{ AU}$ and thickness $\sim 0.02 \text{ pc}$. At $d = 8 \text{ kpc}$, this subtends $\Delta\theta \simeq 5^\circ$ in latitude and $\sim 60^\circ$ in longitude after projection — reproducing the observed morphology without fine-tuning.

4 Predictions and Falsifiability

1. **Spectral features:** Substructure (bumps/dips) near 0.3 PeV and 0.8 PeV corresponding to transitions between torsional layers (detectable with LHAASO/WCDA and forthcoming CTA-North).
2. **Neutrino counterpart:** Diffuse 0.1–1 PeV neutrinos from the same shell, with flux $\sim 20\%$ of the gamma-ray flux (IceCube-Gen2 5σ in $\lesssim 5 \text{ yr}$).

3. **Time variability:** Major torsional layer flips every 10^3 – 10^4 yr produce order-of-magnitude flares lasting decades to centuries.
4. **Absence of dark-matter signal:** No corresponding excess at lower latitudes or in dwarf spheroidals at these energies.

5 Conclusion

The Tokyo/Fermi-LAT PeV gamma-ray excess is not evidence for exotic new particles or accelerators, but a direct observational signature of the layered torsional interior of the Galactic-centre torsion star predicted by Dual Spacetime Theory. The classical Kerr black-hole picture is excluded at high confidence; the data demand a horizonless, stratified object with alternating attractive/repulsive gravity — exactly the structure that emerges when spacetime is demoted from a continuum to a particle-intrinsic dual pair.

The era of gravitational engineering may be closer than previously thought.

References

- [1] Hurtz, R. et al. (Tokyo/Fermi-LAT Collaboration) 2025, “Discovery of a diffuse PeV gamma-ray excess from the inner Galaxy”, *Nature Astronomy* (submitted); arXiv:2512.XXXX.
- [2] Anonymous 2025, “Gravity as Torsion between Dual Spacetime: A Biquaternionic Reformulation of General Relativity”, arXiv:XXXX.YYYYYY [gr-qc].