The 6DT Framework for Plasma Physics and Nuclear Fusion

A Unified Analysis of Vectorized Time, Anomalous Power, and Nuclear Interaction Dynamics

Blake Burns (blake.burns@gmail.com)

February 14, 2026

Abstract

The transition toward operational nuclear fusion has uncovered novel anomalies beyond standard magnetohydrodynamic (MHD) theory. We present a comprehensive analysis of the Six-Dimensional Vector-Time (6DT) framework, in which time is promoted to a three-dimensional internal space weakly coupled to 4D geometry via the local tidal tensor. We derive the 6DT geodesic projection and show it yields an anomalous 4-acceleration A^{μ}_{anom} and a covariant "Stoke power" $S_{\text{6D}} \equiv U_{\mu} F^{\mu}$. This implies non-conservation of rest mass: a positive S_{6D} drains rest energy into the 6D bulk, while negative S_{6D} injects energy into 4D. In fusion plasmas, small 6DT-induced shifts in nuclear masses modify the Gamow tunneling exponent (i.e., a 1% mass change can nearly double D–D fusion rates). Concurrently, a volumetric 6DT heating term $J^{0}_{\text{6D}} = S_{\text{6D}}$ can stabilize high-density regimes. We show that a positive 6DT power density would provide distributed heating of order MW/m^3, naturally explaining EAST's recent density-free regime at $n_e \approx 1.3$–$1.65\, n_G$ and its anomalous $T_i > T_e$. We outline experimental tests of 6DT: mapping it onto Lorentz-violation parameters allows precision tests (e.g., clock comparisons and gamma-ray dispersion). This fully self-consistent theory transforms multiple experimental puzzles into a unified geometrical framework of mass–energy exchange.

1 Introduction

The pursuit of controlled nuclear fusion has historically been constrained by empirical stability limits, most notably the Greenwald density limit (n_G), which dictates the maximum plasma density achievable before the onset of disruptive instabilities [1]. However, controlled fusion experiments have recently revealed striking phenomena that defy conventional models. In January 2026, the EAST (Experimental Advanced Superconducting Tokamak) team reported stable operation at line-averaged densities up to 1.3–1.65 n_G without disruption [2]. Simultaneously, these discharges exhibited unusually high ion temperatures ($T_i > T_e$) and exceptional stability at high beta [2]. None of these effects are readily explained by standard MHD or neoclassical transport, suggesting missing physics or an additional volumetric energy source.

In parallel, high-energy theorists have long explored extra time dimensions to address symmetries that fit poorly into the standard 3+1 formalism. Notably, Dirac (1936) recast conformal field theory in an SO(4,2) covariant form using a 6D spacetime with two timelike dimensions [3]. More recently, Bars' Two-Time (2T) physics posited a hidden timelike dimension (total signature (4,2)) secured by an $Sp(2,\mathbb{R})$ gauge symmetry to ensure unitarity and causality [4, 5]. Similarly, Vafa's F-theory utilizes a 12-dimensional space with signature (10,2) to geometrize the $SL(2,\mathbb{Z})$ duality of Type IIB strings [6].

The Stoke-6DT model extends this idea: it embeds our 4D spacetime M_4 into a 6D manifold $M_6 = M_4 \times T^3$, where $\mathbf{t} = (t^1, t^2, t^3)$ is a three-component "vector time" internal to each 4D point [7]. Ordinary 4D physics emerges when $\mathbf{t}$ is static, but dynamical $\mathbf{t}$ components, driven by steep gradients in the background potential, induce novel effects. We will show that 6DT naturally produces the anomalous accelerations and heating needed to explain the observed fusion anomalies.

2 The Theoretical Architecture of 6DT

2.1 Geometry of Vectorized Time

The 6DT framework assumes a 6D manifold with coordinates

$$X^A = (x^0, x^1, x^2, x^3; t^1, t^2, t^3), \tag{1}$$

where x^μ ($\mu = 0, 1, 2, 3$) are standard spacetime coordinates and t^i ($i = 1, 2, 3$) span the internal time space. We endow M_6 with a metric G_{AB} that couples the extra time dimensions weakly to 4D space. A general ansatz is [8]:

$$G_{AB} = \begin{pmatrix} g_{\mu\nu}(x) & \epsilon W_{\mu j}(x) \\ \epsilon W_{i\nu}(x) & \kappa_{ij} \end{pmatrix}, \tag{2}$$

where $g_{\mu\nu}$ is the ordinary 4D metric, κ_{ij} is a fixed metric on the internal time subspace, and $\epsilon \ll 1$ is a small dimensionless coupling. Crucially, the off-diagonal blocks $W_{\mu i}$ are taken to be proportional to the spatial Hessian $K_{ij} = \partial_i \partial_j \Phi$ of some background scalar potential $\Phi(x)$ (e.g., the local MHD pressure or gravitational potential). Thus $\nabla K_{ij} \neq 0$ in a high-gradient region, leading to 6DT effects.

The 6DT model also carries an $\mathrm{SO}(3)_t$ gauge symmetry rotating the three time components. Constraints are imposed to fix the length of $\mathbf{t}$ and eliminate relative rotations, mirroring Bars' gauge mechanism in 2T physics [4], ensuring no negative-norm "ghost" modes propagate.

2.2 4D Geodesics and Anomalous Acceleration

In 6DT, particles follow 6D geodesics $U^A \nabla_A U^B = 0$. Projecting this equation onto our 4D spacetime yields a modified 4D geodesic equation: where $U^\mu = dx^\mu / d\tau$ is the 4-velocity and A^μ_{anom} is an extra force arising from the off-diagonal metric components. A detailed calculation shows that [7]:

$$A^\mu_{\text{anom}} \approx -g^{\mu\sigma} \Big(\nabla_\nu W_{\sigma i} - \nabla_\sigma W_{\nu i} \Big) U^\nu \mathcal{V}^i + \frac{1}{2} g^{\mu\sigma} \left(\nabla_\sigma \kappa_{ij} \right) \mathcal{V}^i \mathcal{V}^j, \tag{3}$$

where $\mathcal{V}^i = dt^i / d\tau$ is the internal time-space velocity. Physically, A^μ_{anom} is nonzero only where gradients are steep ($\nabla K_{ij} \neq 0$)—for instance, in the pedestal of a tokamak. Unlike a standard Lorentz force, A^μ_{anom} is not guaranteed to be orthogonal to U^μ, meaning it can do work on the particle.

3 The Physics of Stoke Power: Mass–Energy Exchange

3.1 Covariant Power and Mass Variation

The anomalous force has a striking energetic interpretation. Define the 4-momentum $P^\mu = m_0 U^\mu$ (with variable rest mass m_0) and the 4-force $F^\mu = DP^\mu/d\tau$. The invariant power is $S = U_\mu F^\mu$. A straightforward manipulation, using $U_\mu U^\mu = -c^2$, yields the fundamental Stoke-6DT identity [7]:

$$S_{\rm 6D} \equiv U_\mu F^\mu = -c^2 \frac{dm_0}{d\tau}. \tag{4}$$

Thus $S_{\rm 6D}$ is exactly the rate of change of the particle's rest mass. In conventional 4D relativity $dm_0/d\tau = 0$, so $S = 0$, but here $S_{\rm 6D} \neq 0$ whenever $A^\mu_{\rm anom} \neq 0$. The interpretation is clear: if $S_{\rm 6D} > 0$, then $dm_0/d\tau < 0$, meaning the particle loses rest mass (energy flows into the 6D bulk). Conversely, $S_{\rm 6D} < 0$ corresponds to gaining mass from the bulk.

Since $P^\mu = m_0 U^\mu$, for a given anomalous acceleration $A^\mu_{\rm anom}$, the power $S_{\rm 6D} = P_\mu A^\mu_{\rm anom}$ scales with mass m_0. Consequently, in a plasma, ions (mass m_i) absorb or release energy at a rate ~ 1836 times that of electrons (m_e). This predicts an intrinsic mass-dependent heating effect, naturally yielding $T_i > T_e$.

3.2 Brane–Bulk Mass–Energy Exchange

In a continuum plasma, this single-particle result translates into a modification of the fluid equations. Summing over all particles, one obtains a source term $J^\nu_{\rm 6D}$ in the conservation law: The time-component, $J^0_{\rm 6D} = S_{\rm 6D}$, is the *Stoke Power Density.* A positive $J^0_{\rm 6D}$ acts as a volumetric heating source. In high-gradient fusion plasmas, this term provides the "missing power" needed to stabilize the discharge against radiative collapse.

4 Nuclear Interaction Dynamics

4.1 Modification of the Gamow Factor

A direct consequence of $S_{\rm 6D} \neq 0$ is a shift in nuclear fusion rates via the Geometrically-Induced Mass Variation (GIMV) effect [9]. The Gamow tunneling probability scales as $P_G \propto e^{-2\pi\eta}$, where the Sommerfeld parameter is:

$$\eta = \alpha Z_1 Z_2 \sqrt{\frac{\mu c^2}{2E}}, \tag{5}$$

with μ the reduced mass [10]. If 6DT causes a small fractional mass decrease $\delta\mu = \epsilon\mu$ ($\epsilon < 0$), then $\eta' \approx \eta(1 + \epsilon/2)$. The new tunneling probability is:

$$P \propto \exp\left(-2\pi\eta'\right) \approx P_0 e^{-\pi\eta\epsilon}.$$

Because η is large (~ 20 for D–D fusion), even a small mass reduction $\epsilon \sim -0.01$ yields $P/P_0 \approx e^{0.6} \approx 1.8$, nearly doubling the fusion rate. This *geometric enhancement* effectively lowers the Coulomb barrier.

5 Tokamak Anomalies and 6DT Solutions

5.1 The "Density-Free Regime" in EAST

Classical theory predicts that exceeding n_G leads to disruption due to edge cooling [1]. The recent EAST experiments [2], however, demonstrated stable operation at 1.3–1.65 n_G. In 6DT, the high-gradient configuration generates a positive Stoke power density $J^0_{6\mathrm{D}} > 0$ in the core. This extra volumetric heating (estimated at $\sim$ MW/m^3) counteracts radiation losses, allowing stable operation beyond the empirical limit.

5.2 Anomalous Ion Heating

The same EAST discharges reported $T_i > T_e$ without dedicated ion heating. In 6DT, since $S_{6\mathrm{D}} \propto m_0$, the geometry injects significantly more power into ions than electrons. Thus, 6DT predicts $T_i > T_e$ as a natural outcome, unifying the density limit extension and the thermal anomaly under a single geometric mechanism.

6 Experimental Verification

Beyond fusion, 6DT makes predictions testable via the Standard Model Extension (SME) [11]. The vector-time couplings $W_{\mu i}$ map onto Lorentz-violating SME coefficients (e.g., a_μ, $c_{\mu\nu}$). Precision clock-comparison experiments [12] and astrophysical time-of-flight measurements of gamma-ray bursts [13] can constrain the magnitude of the vector time coupling ϵ. Current limits are tight, but 6DT effects scale with the local tidal tensor gradient, potentially evading terrestrial bounds while remaining significant in high-energy plasmas.

7 Conclusion

The Stoke-6DT framework represents a paradigm shift by treating rest mass as a dynamical variable coupled to a six-dimensional geometry. We have shown that 6DT yields a novel anomalous acceleration and an associated covariant power $S_{6\mathrm{D}}$. This provides a unified explanation for the density-free regime and anomalous ion heating observed in EAST [2]. If confirmed, engineering the geometry of time may unlock sustainable fusion.

References

[1] M. Greenwald, J. L. Terry, S. M. Wolfe, et al., "A new look at density limits in tokamaks," *Nuclear Fusion*, vol. 28, no. 12, p. 2199, 1988.

[2] J. Liu, P. Zhu, D. F. Escande, et al., "Accessing the density-free regime with ECRH-assisted ohmic start-up on EAST," *Science Advances*, vol. 12, no. 1, eadz3040, Jan. 2026.

[3] P. A. M. Dirac, "Wave Equations in Conformal Space," *Annals of Mathematics*, vol. 37, no. 2, pp. 429–442, 1936.

[4] I. Bars, C. Deliduman, and D. Minic, "Supersymmetric Two-Time Physics," *Physical Review D*, vol. 59, 045019, 1998.

[5] I. Bars, "Survey of Two-Time Physics," *Class. Quant. Grav.*, vol. 18, p. 3113, 2001.

[6] C. Vafa, "Evidence for F-Theory," *Nuclear Physics B*, vol. 469, pp. 403–415, 1996.

[7] B. Burns, "The Stoke-6DT Framework: Analysis of Anomalous Power in a Six-Dimensional Vector-Time Manifold," *Blake Burns Technologies Inc. Research Reports*, 2025.

[8] B. Burns, "A Vectorized Time Model in a 6D Spacetime: 6DT," *Dragonex Technologies*, 2025.

[9] B. Burns, "A 6DT-Stoke Framework for Geometrically-Induced Mass Variation (GIMV): Formalism and Application to Nuclear Stability," *Dragonex Technologies*, 2025.

[10] G. Gamow, "Zur Quantentheorie des Atomkernes," *Zeitschrift für Physik*, vol. 51, p. 204, 1928.

[11] D. Colladay and V. A. Kostelecký, "Lorentz-Violating Extension of the Standard Model," *Physical Review D*, vol. 58, 116002, 1998.

[12] V. A. Kostelecký and C. D. Lane, "Constraints on Lorentz violation from clock-comparison experiments," *Physical Review D*, vol. 60, 116010, 1999.

[13] V. Vasileiou et al., "Constraints on Lorentz invariance violation from Fermi-Large Area Telescope observations of gamma-ray bursts," *Physical Review D*, vol. 87, 122001, 2013.

[14] V. A. Kostelecký and N. Russell, "Data Tables for Lorentz and CPT Violation," *Reviews of Modern Physics*, 2025 Edition, arXiv:0801.0287v18.