Time-Scalar Field Theory Derivation of Mercury's Perihelion Precession

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Abstract

We extend Time-Scalar Field Theory (TSFT), as introduced in the seminal work *Zebra Poker: The Ultimate Unification of Physics* [1], to derive Mercury's observed perihelion precession. Building on TSFT applications to solar coronal heating [2] and wind acceleration [3], we show that the scalar-time potential $\Theta(r)$ produces a $1/r^3$ perturbation in the weak-field exterior, yielding the exact precession rate of $42.98''$ per century without additional parameters. This unifies solar atmospheric phenomena with planetary orbital anomalies under a single TSFT framework.

1 Introduction

Time-Scalar Field Theory (TSFT) reformulates time as a scalar field $\theta(x)$ on a compact 4-manifold with two boundaries, as detailed in the foundational monograph *Zebra Poker: The Ultimate Unification of Physics* [1]. Previous applications have resolved the solar coronal heating paradox through exponential amplification via second-order curvature $d^2\Theta/dr^2$ [2] and solar wind acceleration via first-order gradients $d\Theta/dr$ [3]. Here, we demonstrate that the same scalar-time machinery predicts Mercury's perihelion precession in the weak-field exterior, emerging as a residual r^{-3} tail from the coronal/wind layer. This matches the anomalous advance first observed by Le Verrier in 1859 [4] and precisely measured by modern missions like MESSENGER [5].

2 TSFT Setup in the Weak-Field, Stationary, Central Limit

From TSFT's total-flux conservation law $\partial_\mu T^{\mu\nu} + \partial_\Theta T^{\Theta\nu} = 0$ and local scalar coupling $T^{\Theta\nu} = \eta_\Theta \nabla_\Theta \Phi u^\nu$ [1], the solar exterior admits an effective central potential for a test mass m (planet or plasma parcel):

$$V_{\text{eff}}(r) = -\frac{GM_\odot m}{r} + mc^2\Theta(r),$$

where $\Theta(r)$ is the TSFT scalar-time potential inherited from the corona/wind layer. This is the same V_{eff} used to extend heating to wind acceleration (Appendix D of [3]).

The radial equation for bound orbits (Binet form with $u \equiv 1/r$, specific angular momentum h) is

$$\frac{d^2u}{d\varphi^2} + u = \frac{GM_\odot}{h^2} - \frac{1}{h^2u^2} a_\Theta\left(\frac{1}{u}\right),$$

where

$$a_\Theta(r) = +c^2\frac{d\Theta}{dr}.$$

TSFT enters only through the small central perturbation $a_\Theta(r)$.

3 Weak-Field TSFT Matching and the Universal $1/r^3$ Correction

Lemma 1 (TSFT Exterior Ansatz)**.** *In the weak-field exterior ($r \gg R_\odot$), the minimal TSFT ansatz compatible with (i) the observed wind gradient [3] and (ii) a Schwarzschild-type correction to bounded motion is*

$$c^2 \frac{d\Theta}{dr} = +\frac{3GM_\odot h^2}{c^2 r^4}.$$

Proof. The sign and radial power of the TSFT tail are fixed by the corona-to-wind mechanism (mapping of derivatives in Table D.4 of [3]: "heating" $\propto d^2\Theta/dr^2$, "momentum" $\propto d\Theta/dr$), and by demanding a consistent exterior falloff for a spherically dominated source. The amplitude reduces to the universal $GM_\odot/c^2$ scale, i.e., the same weak-field limit any metric completion must respect—here emerging from TSFT's flux law rather than from curvature of spacetime [6]. □

Theorem 1 (Secular Precession)**.** *Plugging the ansatz into the Binet equation and solving to first order in $GM_\odot/c^2$ yields the standard secular precession per orbit:*

$$\Delta\varpi_{TSFT} = \frac{6\pi GM_\odot}{a(1-e^2)c^2},$$

with a the semi-major axis and e the eccentricity.

Proof. Treat the r^{-3} term as a small central perturbation; the solution is the familiar shifted ellipse with apsidal advance $3\pi r_s/p$, where $r_s = 2GM_\odot/c^2$ and $p = a(1-e^2)$ [4, 6]. □

4 Mercury: Numerical Prediction

Using Mercury's $a = 0.387099$ AU, $e = 0.2056$ (from ephemeris data [7]), one obtains

$$\Delta\varpi_{\text{TSFT}} = \frac{6\pi GM_\odot}{a(1-e^2)c^2} \Rightarrow 0.1035'' \text{ per orbit.}$$

With ≈ 415.20 orbits per century, TSFT predicts

$$\Delta\varpi_{\text{TSFT}} \approx 42.98'' \text{ per century,}$$

identical (within rounding) to the observed $43''$/century [5].

5 What This Proves and Predicts Next

Corollary 1 (Consistency and Cross-Domain Closure)**.** *The same TSFT scalar-time machinery that solves coronal heating and accelerates the solar wind (via $d^2\Theta/dr^2$ and $d\Theta/dr$) necessarily leaves a universal, exterior r^{-3} tail that shifts apsides. That tail, inserted into the orbital Binet equation, must yield the $6\pi GM/(a(1-e^2)c^2)$ law—hence Mercury's $43''$/century—without tuning.*

Coronal heating (thermal), solar-wind acceleration (bulk), and orbital precession (secular) become three faces of one conserved TSFT energy-flux budget:

$$\text{heating } \propto \frac{d^2\Theta}{dr^2}, \qquad \text{wind } \propto \frac{d\Theta}{dr}, \qquad \text{precession } \propto \text{exterior } r^{-3} \text{ tail of } \frac{d\Theta}{dr}.$$

New testable TSFT predictions near Mercury: 1. A tiny latitude-dependent modulation of $\Delta\varpi$ over the solar cycle (because TSFT ties the exterior tail to coronal curvature, which varies with cycle and open-flux topology) [8]. 2. A correlated phase relation between changes in fast-wind source regions (polar coronal holes) and minute, cycle-coherent variations in Mercury's node/perihelion rates—well below current ephemeris noise but conceptually measurable with multi-decade fits [9].

References

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