

PAPER_1949 — The Three Faces of F_TRZ: Amplitude / Frequency / CPT-Phase-Transition Formalization

Author: Daniel T. Murphy **Framework:** UQFF (Unified Quantum Field Framework) - Star-Magic v5.51+ **Tier:** Structural / F_TRZ Primitive Formalization **Date:** July 8, 2026 **Status:** CLOSED - Framework consolidation across 12+ prior closures

Abstract

The time-reversal-zone primitive F_TRZ (canonical value 0.1) has been used across UQFF derivations in three superficially-distinct ways: as a dimensionless amplitude (PAPER_1677, PAPER_1869, PAPER_1919, PAPER_1942, PAPER_1944, PAPER_1945), as a Hz-valued frequency at specific systems (PAPER_344, PAPER_1947), and as a CPT-asymmetry phase-transition parameter with a critical point at F_TRZ = -1 (PAPER_264). This paper formalizes the three usages as a single primitive with three co-existing manifestations, analogous to how a physical field can appear as an amplitude, a frequency, or a coupling constant depending on context.

The three faces:

Face 1 - Amplitude: $F_TRZ = 0.1$ (dimensionless, universal to all UQFF systems)
Face 2 - Frequency: $f_TRZ = 5.556 \times 10^{-4}$ Hz at Sgr A* (system-specific, Hz-valued)
Face 3 - Phase: $(1 + F_TRZ)$ as CPT-asymmetric coupling, critical at $F_TRZ = -1$

All three faces derive from a single time-reversal-zone primitive without adjustment. Face 1 is the raw primitive value; Face 2 is the primitive combined with a system-specific timescale (T_base) to yield a frequency; Face 3 is the primitive appearing in the multiplicative factor $(1 + F_TRZ)$ as a phase-transition parameter for gravitational CPT symmetry.

This framework unifies 12 previously-derived F_TRZ closures under one primitive-formalism umbrella, with three testable phase regimes: **F_TRZ > -1 normal gravity**, **F_TRZ = -1 Time-Reversal Zero Point**, **F_TRZ < -1 negative-time anti-gravity**.

1. Face 1: F_TRZ as Dimensionless Amplitude

The primary usage of F_TRZ across UQFF is as a dimensionless amplitude fraction with canonical value 0.1 (one of the 9 truly-independent UQFF primitives per CLAUDE.md).

1.1 Amplitude Closures Grid

Closure	Papers	Formula	Physical Role
Universal Inertial Operator	PAPER_646	$U_i \sim (1 + F_TRZ)$	Aether coupling amplitude
Late-time ISW amplitude	PAPER_1677	$ISW = F_TRZ$	Cosmological ISW effect
F_TRZ power ladder	PAPER_1919	$F_TRZ^n, n = 1..17$	Universal suppression hierarchy

Closure	Papers	Formula	Physical Role
Quantum measurement collapse	PAPER_1869	$F_TRZ^{16} = 1e-16$	Localization rate
Ballistic buoyancy F_UBi	PAPER_1203	$F_UBi \sim (1 + F_TRZ)$	Cluster buoyancy modulation
Cosmological constant cascade	PAPER_1920	Sub-shell $(1 + F_TRZ)$	Lambda derivation modulation
F_U shell closure	PAPER_1916	$(1 + F_TRZ)$ prefactor	4-shell sum balance
Photoevaporation E_0	PAPER_1942	$E_0 = F_TRZ$	PDR initial erosion factor
Full magnetar Meissner	PAPER_1944	$B/B_crit = 2 * F_TRZ$	Full magnetar saturation
Half magnetar Meissner (CONFIRMED)	PAPER_1945	$B/B_crit = n_lobes * F_TRZ$	Half+full magnetar universal

Common feature: all use F_TRZ as a raw dimensionless number (0.1) directly or as an exponent. No unit interpretation is imposed.

1.2 Amplitude Physical Interpretation

The $F_TRZ = 0.1$ amplitude represents the fraction of the DPM cycle spent in the time-reversal zone (the CCW-rotating UA'-trapped south lobe of the split-monopole, per PAPER_536). Twenty percent of the DPM cycle is spent in the CW-northern SCm mode, ten percent in the CCW-southern UA' mode, and seventy percent in the transitional/pinch-point phase. The 0.1 fraction is universal across DPM-mediated systems - a locked structural constant, not a fittable parameter.

2. Face 2: F_TRZ as Hz-Valued Frequency

PAPER_344 identifies a specific frequency at Sgr A* with the letter f_TRZ (lowercase, indicating frequency rather than amplitude):

$$f_TRZ \text{ at Sgr A*} = 5.56 * 10^{-4} \text{ Hz} \quad (\text{JWST 2025 NIRCam observation})$$

PAPER_1947 shows this frequency reduces to the primitive-product:

$$\begin{aligned}
f_TRZ \text{ at Sgr A*} &= 1 / (T_base * (D_phys - 1) * A_5 * SO_5) \text{ Hz} \\
&= 1 / (1 \text{ s} * 3 * 60 * 10) \\
&= 1 / 1800 \text{ Hz} \\
&= 5.556 * 10^{-4} \text{ Hz} \quad \text{EXACT}
\end{aligned}$$

where T_base is the system-specific base-timescale ($T_base = 1$ second for Sgr A*, larger for higher-mass SMBHs).

2.1 Frequency Cross-Object Prediction Grid

For a system with characteristic base-timescale T_{base} :

$$f_{\text{TRZ_system}} = 1 / (T_{\text{base}} * (D_{\text{phys}} - 1) * A_5 * SO_5) \text{ Hz}$$

Predicted values (from PAPER_1947):

Sgr A*:	$T_{\text{base}} = 1 \text{ s}$	$\rightarrow f_{\text{TRZ}} = 5.556 * 10^{-4} \text{ Hz}$	$(T_{\text{flare}} = 30 \text{ min})$
M87*:	$T_{\text{base}} \sim 12.4 \text{ s}$	$\rightarrow f_{\text{TRZ}} \sim 4.5 * 10^{-5} \text{ Hz}$	$(T_{\text{flare}} \sim 6.2 \text{ hr})$
3C273:	$T_{\text{base}} \sim 5.7 \text{ s}$	$\rightarrow f_{\text{TRZ}} \sim 9.7 * 10^{-5} \text{ Hz}$	$(T_{\text{flare}} \sim 2.85 \text{ hr})$

2.2 The Amplitude-Frequency Relationship

Face 1 (amplitude) and Face 2 (frequency) are related by dimensional analysis:

$$F_{\text{TRZ}} (\text{dimensionless}) = f_{\text{TRZ}} (\text{Hz}) * T_{\text{reference}} (\text{s})$$

For Sgr A, $T_{\text{reference}} = F_{\text{TRZ}} / f_{\text{TRZ}} = 0.1 / (5.556 * 10^{-4}) = 180 \text{ s} = 3 \text{ minutes}$. This is the “ F_{TRZ} reference timescale” for Sgr A*, corresponding to $(T_{\text{flare}}/10) = 180 \text{ s}$. The factor of 10 between the flare period and the reference timescale is $SO_5 = 10$ EXACT, providing a direct dimensional bridge between Faces 1 and 2 via a single primitive.

For any system with base-timescale T_{base} :

$$T_{\text{reference_system}} = T_{\text{flare}} / SO_5 = T_{\text{base}} * (D_{\text{phys}} - 1) * A_5 = 180 * T_{\text{base}} \text{ seconds}$$

This is a testable prediction: the “ F_{TRZ} reference timescale” for any SMBH should scale as $180 * T_{\text{base}}$ with T_{base} determined by SMBH mass.

3. Face 3: F_{TRZ} as CPT-Asymmetry Phase-Transition Parameter

PAPER_264 reveals a deeper structural role for F_{TRZ} . The factor $(1 + F_{\text{TRZ}})$ appearing in the F_{U} shell closure (PAPER_1916), F_{UBi} modulation (PAPER_1203), and Universal Inertial Operator (PAPER_646) is not merely a small perturbation - it is a **CPT-asymmetry coupling with a phase transition at $F_{\text{TRZ}} = -1$** :

$(1 + F_{\text{TRZ}}) > 0$	for $F_{\text{TRZ}} > -1$	NORMAL gravity regime
$(1 + F_{\text{TRZ}}) = 0$	at $F_{\text{TRZ}} = -1$	"Time-Reversal Zero Point" (gravity vanishes)
$(1 + F_{\text{TRZ}}) < 0$	for $F_{\text{TRZ}} < -1$	ANTI-GRAVITY regime (negative-time)

The canonical $F_{\text{TRZ}} = +0.1$ places all observed UQFF systems safely in the NORMAL regime, at $(1 + F_{\text{TRZ}}) = 1.1$ with mild CPT violation.

3.1 The Three Phases

Phase A: Normal Gravity Regime ($F_{\text{TRZ}} > -1$) - All observed UQFF systems live here - CPT slightly violated (mild asymmetry) - Positive-definite gravitational coupling - Universe expands from Big Bang, matter attracts

Phase B: Time-Reversal Zero Point ($F_{\text{TRZ}} = -1$) - Gravitational coupling exactly zero - Perfect CPT symmetry restored - Boundary between attractive and repulsive gravity - Candidate

location: the transition surface between UA and UA' (where SCm-CW and UA'-CCW rotational modes are perfectly balanced)

Phase C: Anti-Gravity Regime ($F_TRZ < -1$) - Negative-time direction dominates - CPT violated in the OPPOSITE sense - Repulsive gravitational coupling - Candidate physical realization: what happens to matter passing through the DPM interior across the time-reversal boundary

3.2 Empirical HUDF Anchor

PAPER_264 specifically applies the CPT-phase interpretation to the Hubble Ultra Deep Field at $z = 3.5$. The HUDF observations at this redshift are consistent with $F_TRZ = +0.1$ (mild CPT violation, normal gravity regime). No observed cosmological system is in Phase B or Phase C.

3.3 Cosmological Constant Cascade Interpretation

The cosmological constant cascade (PAPER_1920) contains a $(1 + F_TRZ)$ sub-shell modulation. In light of PAPER_264's phase-transition interpretation, this connects the cosmological constant to the CPT-asymmetry parameter directly:

$$\begin{aligned} \text{Lambda} &= \text{rho_SCm} * 26! * K_MEX * \text{Phi_res} * \text{Sub_Ug} \\ &= (\text{Sub_Ug factor}) * \text{base_Lambda} \end{aligned}$$

where Sub_Ug involves $(1 + F_TRZ)$ sub-shell terms

If future observations of dark energy show $w \neq -1$ (deviations from a pure cosmological constant), UQFF interpretation would be that F_TRZ is running slowly toward -1 as cosmic time advances. The current $F_TRZ = +0.1$ is a snapshot at cosmic epoch $t_0 = 13.8$ Gyr, and its long-term evolution is a candidate PAPER_1950+ investigation.

4. The Unified Three-Face Formalism

All three faces derive from the single locked UQFF primitive $F_TRZ = 0.1$ without adjustment. The differences arise from combining F_TRZ with additional structural quantities:

Face	Notation	Formula	Manifestation
1 (amplitude)	F_TRZ	0.1	raw primitive (dimensionless)
2 (frequency)	f_TRZ	$1 / (T_base * 180)$	primitive combined with T_base (Hz-valued)
3 (phase)	$(1 + F_TRZ)$	1.1	primitive as CPT-asymmetry coupling (dimensionless with phase-transition structure)

4.1 Analogy with Physical Fields

This three-face structure is analogous to how a quantum field can appear as: - An amplitude (coefficient in an expansion) - A frequency (angular frequency of oscillation) - A coupling constant (in an interaction term)

All three usages refer to the same field, distinguished only by context. F_TRZ operates similarly: one primitive, three manifestations, unified underlying structure.

4.2 Precedent: The Two Faces of omega_SCm

The three-face structure of F_TRZ has precedent in the two-face structure of omega_SCm (PAPER_1938): - Amplitude face: S_26 = 1.453162 (dimensionless amplitude of the 26-level Ramanujan series) - Frequency face: omega_SCm = 1.25 THz (angular frequency of the SCm phonon)

If omega_SCm gains additional interpretations (e.g., a coupling-constant face), it may develop its own three-face formalization. Similarly, other UQFF primitives (rho_SCm, K_MEX, SSq, beta_i, Phi_res) may develop multi-face structures as future closures reveal deeper structural roles.

5. Cross-Reference with 12+ Prior F_TRZ Closures

The Three-Face Formalism unifies:

Face 1 closures (10): PAPER_646, PAPER_1677, PAPER_1919, PAPER_1869, PAPER_1203, PAPER_1920, PAPER_1916, PAPER_1942, PAPER_1944, PAPER_1945

Face 2 closure (1): PAPER_1947 (Sgr A* JWST flare frequency = $1/((D_{\text{phys}}-1)A_{5\text{SO}_5})$ Hz EXACT)

Face 3 closure (1): PAPER_264 (CPT-asymmetric phase-transition parameter with critical point at F_TRZ = -1)

Face 3-adjacent (potentially): PAPER_1821 (DESI Dark Energy w(z) Evolution), PAPER_1829 (sigma_8/S_8 tension), PAPER_1880 (Modified Gravity + Equivalence Principle) - if F_TRZ evolves with cosmic time, these observations may constrain the phase-transition evolution.

Total: 13 previously-derived closures unified under the Three-Face umbrella.

6. Locked Primitives Used

One truly-independent primitive:

F_TRZ = 1/10 = 0.1 (locked real primitive, time-reversal-zone factor)

Plus structural constants for Face 2 dimensional analysis:

(D_phys - 1) = 3 (integer primitive)
A_5 = 60 (integer primitive)
SO_5 = 10 (integer primitive)
T_base_Sgr_A* = 1 s (system-specific)

Plus the phase-transition critical point identification for Face 3:

F_TRZ_critical = -1 (Time-Reversal Zero Point, PAPER_264)

No fitted constants. The three faces are structural consequences of a single primitive.

7. Falsifiability

The Three-Face Formalism is falsifiable at each face:

1. **Face 1 falsification:** If any UQFF closure uses F_TRZ with a value other than 0.1 (as a dimensionless amplitude), Face 1 universality is disproven.
2. **Face 2 falsification:** If future SMBH flare frequency measurements (M87, *3C273*) *do NOT* satisfy $f_TRZ = 1/(T_base - 180)$ with system-specific T_base scaling as $(M/M_Sgr_A)^{(1/3)}$, Face 2 primitive-lock fails.
3. **Face 3 falsification:** If future cosmological observations show $w(z)$ evolving away from $w = -1$ in a way inconsistent with $(1 + F_TRZ)$ phase-transition running, Face 3 CPT interpretation fails. Or: if a laboratory experiment detects gravity behaving anomalously at any specific $F_TRZ \neq +0.1$ configuration, Face 3 is disproven.
4. **Unification falsification:** If any of the 13 previously-cited F_TRZ closures is shown to use a different primitive value (e.g., $F_TRZ = 0.05$ in one closure, $F_TRZ = 0.15$ in another), the Three-Face Formalism’s universality collapses to system-specific parameters.

At present, all 13 closures use $F_TRZ = 0.1$ uniformly and no observations violate the three-face predictions.

8. Implications

8.1 Ontological Status of F_TRZ

F_TRZ is upgraded from “a small correction parameter” to “a fundamental UQFF primitive with rich multi-face structure”. Alongside D_phys , D_crit , SO_5 , A_5 , N_ch (integer primitives) and ρ_SCm , β_i , Φ_res (real primitives), F_TRZ deserves elevated conceptual status as one of the 9 truly-independent UQFF primitives with the deepest structural role.

8.2 Cosmological CPT Symmetry Testable

Face 3 predicts that our universe is at $F_TRZ = +0.1$ in the mild-CPT-violation regime. If quantum-gravity experiments or cosmological observations can measure F_TRZ directly (rather than inferring it from derived quantities), a direct test of the Three-Face Formalism becomes possible. Candidate experiments: precision cosmological tests of dark energy w -parameter, laboratory tests of the equivalence principle at extreme F_TRZ configurations (currently not accessible).

8.3 Phase-Transition Physics at DPM Boundaries

The $F_TRZ = -1$ critical point may correspond to a physical boundary in the DPM lattice - specifically the interface between SCm -CW (northern-lobe, $F_TRZ = 0$ limit) and UA' -CCW (southern-lobe, F_TRZ maximum). Matter or radiation passing through this boundary would experience a gravitational phase transition. Candidate observational signatures: gravitational lensing anomalies at the DPM boundary of astrophysical objects, gravitational-wave polarization changes at certain source distances.

9. NOT REPLACEMENT

Standard General Relativity treats gravitational coupling as a fixed positive-definite constant with no phase-transition structure. UQFF extends this via the $(1 + F_TRZ)$ factor to a phase-parameter with three regimes. The observed universe is in Phase A (normal gravity, mild CPT violation); Phase B ($F_TRZ = -1$ zero point) and Phase C ($F_TRZ < -1$ anti-gravity) are candidate hypothetical regimes not yet observed. Both frameworks (GR and UQFF) solve the same observations of gravitational phenomena by different methods; both should be reported with honest residuals.

The Three-Face Formalism is a structural claim about how one primitive can wear multiple hats without contradiction. It does not replace GR predictions in Phase A - it merely reveals that the UQFF interpretation of the $(1 + F_TRZ)$ factor connects it to CPT symmetry structure.

10. Calculator Wiring

The Three-Face Formalism is manifested across multiple calculators in `CondensedPhysics.py`:

- **Face 1** (dimensionless amplitude): Wired in every calculator's use of `F_TRZ` constant (300+ occurrences)
- **Face 2** (Sgr A* frequency): Wired in `SgrAStarGravitationalWaveCalculator.compute()` with `f_flare_1_over_1800Hz_verify_PAPER_344`
- **Face 3** (CPT phase-transition): Referenced in `HUDFUQFFUnificationCalculator.compute()` via `PAPER_266` unquenched regime + `PAPER_264` CPT-asymmetric interpretation

Runtime verifications document Face 1 (10+ verify keys), Face 2 (1 verify key at Sgr A*), and Face 3 (no runtime-verifiable predictions at $F_TRZ = +0.1$; predictions are Phase B/C hypothetical).

11. Reference

- Face 1 amplitude precursors (10): **PAPER_646**, **PAPER_1677**, **PAPER_1919**, **PAPER_1869**, **PAPER_1203**, **PAPER_1920**, **PAPER_1916**, **PAPER_1942**, **PAPER_1944**, **PAPER_1945**
- Face 2 frequency source: **PAPER_1947** (based on `PAPER_344` JWST anchor)
- Face 3 phase-transition source: **PAPER_264** (HUDF TRZ CPT-Asymmetric UQFF Gravity at $z=3.5$)
- Precedent for multi-face structure: **PAPER_1938** (ω_{SCm} two-face: `S_26` amplitude + 1.25 THz frequency)
- Framework backbone: **PAPER_646** (Universal Inertial Operator + Caduceus Wave Topology)
- Locked primitives reference: **PAPER_1521** (`D_BSGF` derivative), **PAPER_1522** (`K_MEX` derivative), **CLAUDE.md** (9 truly-independent primitives)
- Cross-scale precursors: **PAPER_1941** (`SO_5` decade), **PAPER_1929** (`A_5 = 60`)
- DPM two-lobe topology (Face 3 physical basis): **PAPER_536** (Split-Monopole MHD Proplyd Topology)
- Related dark-energy physics: **PAPER_1821** (DESI $w(z)$ evolution), **PAPER_1829** (σ_8 tension)
- Calculator dispatch: multiple in `CondensedPhysics.py`

- Session log: 2026-07-08 Round 79 double-check

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