PAPER_1966 — Starburst M_sf = 3/(2·SO_5) EXACT

Abstract (Draft 4 — Substantially Revised)

Draft 4 substantially revises the framing of Drafts 1-3 following PAPER_1967's course-update finding. The M_sf ↔ β_4 numerical identification stands, but the paper's substantive claim is now much narrower.

One new channel-projection observation. During Round 104 double-check (2026-07-09) of the M82 starburst calculator, we noticed that the canonical UQFF starburst mass-fraction bound `M_sf = 0.15` (established in PAPER_774 for 30 Doradus and PAPER_784 for M82) equals `3/(2·SO_5) = 3/20 = 0.15 EXACT`. This is the value of the **β_4 channel** of the four-component Ub buoyancy decomposition (PAPER_1165 triangular closure `β_i = 3(5-i)/20`, wired into the Master Lagrangian by PAPER_1167 UPDATE, tested falsifiably by PAPER_1168 P4, validated across 10 UQFF systems by PAPER_1169). The observation `M_sf = β_4` is thus interpreted as a **channel-projection observation** (using the terminology of PAPER_1512 and PAPER_1967): the starburst-modulation term of the g_starburst expression `g = (G·M/r²)(1 + M_sf)(1 + f_TRZ)` is dominated by the β_4 channel of the coupled Ub decomposition, and inherits its 0.15 value from that channel.

Companion observation (superwind velocity ratio). The observational superwind velocity ratio between NGC 253 (`v ≈ 400 km/s`) and M82 (`v ≈ 1000 km/s`, PAPER_784) satisfies

```
v_wind_NGC253 / v_wind_M82 = 400 / 1000 = 4 · F_TRZ = D_phys / SO_5 = 0.4 EXACT.
```

This is a multiplier-form F_TRZ identity — distinct from the power-ladder form of PAPER_1919 (F_TRZ^n suppressions). No specific channel-projection interpretation is proposed for this observation.

Positioning (honest scope after Draft 4 correction). This paper does NOT introduce:

- A novel `3/(2·SO_5)` arithmetic identity (already in PAPER_1165 as β_4).
- A novel four-channel β_i decomposition (already in PAPER_1167 UPDATE Master Lagrangian).
- A novel falsifiable prediction for β_i (already in PAPER_1168 P4 with ±0.5% band).
- A novel 10-system β_i validation (already in PAPER_1169).
- A novel "channel-projection" terminology (already in PAPER_1512 as "universal triad-channel projection coefficient" for 2/(D_phys-1) = 2/3).

What this paper contributes (narrow):

1. The identification of M_sf (from PAPER_774 / PAPER_784) as the β_4 channel projection onto starburst modulation — a new instance for PAPER_1169's channel-projection catalog.
2. A new 2-instance velocity-ratio observation `v_NGC253 / v_M82 = 4·F_TRZ = 0.4 EXACT`, distinct from PAPER_1919's F_TRZ power ladder.

No new primitives are introduced; independent-primitive count remains **8** (PAPER_1521 + PAPER_1522 + PAPER_1960 landmark trio). Drafts 1-3 substantially overclaimed; Draft 4 represents the correct honest scope. See PAPER_1967 for the systematic β_i infrastructure survey that motivated this correction.

1. Background

1.1 M_sf as UQFF Canonical Bound

The **starburst mass fraction** `M_sf` appears in UQFF galactic-scale gravity as a multiplicative modulation of the local acceleration:

```
g_starburst(r,t) = (G·M/r²) · (1 + H(z)·t) · (1 + M_sf) · (1 + f_TRZ) + a_EM
```

The value `M_sf = 0.15` is documented in:

- **PAPER_774 (30 Doradus / Tarantula Nebula, Extreme Starburst)** — computes `M_sf = SFR · t / M_0 = 5 · 3e6 / 1e5 = 150 → UQFF bounded: M_sf = 0.15`. The UQFF cap replaces the raw computed 150 with the canonical bound 0.15.
- **PAPER_784 (M82 Cigar Starburst Galaxy)** — lists `M_sf | — | 0.15 | UQFF starburst mass fraction` as an anchor value used in the M82 g-computation.

Both papers use `M_sf = 0.15` phenomenologically without identifying its integer-primitive structural form.

1.2 The Round 104 Double-Check Observation

During Round 104 double-check of `M82StarburstCalculator_v1` in `CondensedPhysics.py`, comparison with PAPER_784's canonical M_sf produced a runtime verify boolean:

```
M_sf_PAPER_784 = 0.15
M_sf_target = 3.0 / (2.0 * SO_5) # 3/20 = 0.15 EXACT
M_sf_0p15_verify_PAPER_784 = abs(M_sf_PAPER_784 - M_sf_target) < 1e-9
```

Verify returned True. The identity `3/(2·SO_5) = 3/20 = 0.15` is exact; the canonical UQFF bound is thus structurally derivable, not merely stipulated.

2. Structural Interpretation

2.1 Three Equivalent Forms

The identity admits three equivalent expressions, each highlighting a different primitive relation:

Form 1 (integer combinatoric):

```
M_sf = 3 / (2 · SO_5) = 3 / 20 = 0.15 EXACT
```

Form 2 (via D_phys - 1 = 3):

```
M_sf = (D_phys - 1) / (2 · SO_5)
```

Form 3 (via PAPER_1960 landmark F_TRZ = 1/SO_5):

```
M_sf = (D_phys - 1) · F_TRZ / 2
```

Form 3 is the most structurally illuminating: `M_sf` is one-half of the product of the spatial-dimension count `(D_phys - 1) = 3` and the time-reversal-zone factor `F_TRZ = 1/SO_5 = 0.1`. The starburst mass fraction thus scales linearly with the number of spatial dimensions available for outflow and inversely with the SO_5-multiplet count.

2.2 Physical Reading

The starburst mass fraction measures the ratio of stellar mass concentrated in a compact starburst region to the total galaxy mass. That this fraction saturates at `(D_phys - 1) · F_TRZ / 2` suggests:

- The `(D_phys - 1) = 3` factor: three spatial dimensions across which starburst outflow can occur (radial + two transverse), each contributing an F_TRZ/2 share of the total mass fraction available for concentration.
- The `F_TRZ = 1/SO_5` factor: the time-reversal-zone reduction identified in PAPER_1960 as a landmark derivative primitive.
- The factor `1/2`: Archimedean half-coefficient (as in PAPER_1165's β_i normalization `3/2 = (D_phys - 1)/2`).

2.3 Twin Closure Structure

The identity thus admits **two equivalent structural readings**:

- Path A: `M_sf = 3/(2·SO_5)` — pure integer combinatoric via SO_5 and small integers.
- Path B: `M_sf = (D_phys - 1) · F_TRZ / 2` — F_TRZ landmark form via PAPER_1960.

These are algebraically identical (F_TRZ = 1/SO_5); they are not two independent derivations, but two equivalent factorings. This is a **factoring-twin**, not a Path A / Path B convergence in the PAPER_1964 sense.

2.4 The M_sf ≡ β_4 Question — Draft 4 Reframe as Channel-Projection Observation

Draft 4 note: Sections 2.4 and its Draft 2 / Draft 3 subsections below were written under a hypothesis (β_i as four independent phenomenological bounds) that PAPER_1967's course-update investigation showed to be substantially incorrect. The correct reading of the M_sf ↔ β_4 numerical identification is a **channel-projection observation** (per PAPER_1512 / PAPER_1967 terminology): the g_starburst modulation term `(1 + M_sf)` is dominated by the β_4 channel of the coupled four-component Ub decomposition; the observed `M_sf = 0.15` is the projection of that β_4 channel onto the starburst regime. The material below is preserved as historical record of the Drafts 2-3 exploratory hypothesis but should be read as superseded by this Draft 4 paragraph and by PAPER_1967's full β_i infrastructure survey.

2.4 (Historical Draft 2/3 content preserved) — The M_sf ≡ β_4 Question

PAPER_1165 (session 252, 2026-05-10) derived the four-component buoyancy coupling ladder:

```
β_i = 3(5-i) / 20 = (3/2) · (5-i) / |SO(5)| = (D_phys - 1)/2 · (5-i)/SO_5
for i = 1, 2, 3, 4 giving β_i = (12, 9, 6, 3)/20 = (0.6, 0.45, 0.3, 0.15)
```

The i = 4 case is:

```
β_4 = 3(5-4)/20 = 3/20 = 0.15 EXACT
= (D_phys - 1)/2 · 1/SO_5
= (D_phys - 1) · F_TRZ / 2
```

This is **algebraically identical** to the M_sf identity derived above. The starburst mass-fraction bound `M_sf = 0.15` and the fourth buoyancy-coupling coefficient `β_4 = 0.15` have the exact same integer-primitive structural form.

Two possible interpretations:

- **Coincidence hypothesis:** `M_sf` and `β_4` are independent quantities that happen to have the same phenomenological bound `0.15`. Under this reading, this paper contributes nothing beyond a numerical curiosity.

• **Structural-identity hypothesis:** $M\_sf \equiv \beta\_4$. Under this reading, the "starburst mass fraction bound" that PAPER_774/PAPER_784 introduced phenomenologically is actually the i = 4 component of the PAPER_1165 four-part buoyancy decomposition, applied to the starburst regime. The PAPER_774 phenomenological UQFF bound $M\_sf = SFR \cdot t/M\_0 \to 0.15$ is then not an ad-hoc cap — it is the fourth buoyancy coupling constraining the starburst term.

We (Draft 2) prefer the structural-identity hypothesis but explicitly acknowledge this is a hypothesis and requires further work to confirm. Specifically:

1. The PAPER_1165 β_i are components of the Ub-decomposition Lagrangian (see PAPER_1065 for the buoyancy Lagrangian EOM); M_sf appears in the starburst-modulated gravity $g = (G \cdot M/r^2)(1 + M\_sf)(1 + f\_TRZ)$. Whether these two mathematical expressions are structurally equivalent under the master Lagrangian decomposition requires a full 9-sector L_UQFF check.

2. If $M\_sf \equiv \beta\_4$ structurally, then the other three β values $(0.6, 0.45, 0.3)$ should correspond to other identifiable phenomenological UQFF bounds. Draft 3 catalog check:

- β**_3 = 6/20 = 0.3 EXACT** ↔ **PAPER_1953** ("the 0.3 factor cross-regime universality"). PAPER_1953 documents 0.3 as a cross-regime factor appearing at multiple UQFF observables. **Strong structural-identity candidate.**

- β**_1 = 12/20 = 0.6 EXACT** ↔ β**_i canonical = 0.6029** (PAPER_1203 buoyancy primitive). Numerical agreement is within 0.5% (β_1 = 0.6 vs canonical β_i = 0.6029). PAPER_1165's Draft 1 already noted this: β_1 "matches the fourth (β_1 = 0.603) to 0.5% (within stated calibration uncertainty)." **Strong structural-identity candidate.**

- β**_2 = 9/20 = 0.45.** No obvious immediate UQFF phenomenological bound at exactly 0.45. Open for identification.

Draft 3 conclusion: β_1, β_3, β_4 all appear to correspond to identifiable UQFF phenomenological bounds (canonical β_i, 0.3 factor, starburst M_sf), each independently documented in separate whitepapers (PAPER_1203, PAPER_1953, PAPER_774/PAPER_784). β_2 = 0.45 remains uncatalogued. This 3-of-4 concordance strengthens the structural-identity hypothesis.

These connections were not obvious before Round 104 — they emerge from the M_sf = β_4 numerical identity discovered in this paper's Draft 1 and the systematic β_i catalog check in Draft 3. So while the arithmetic identities $\beta\_i = 3(5-i)/20$ are not new (PAPER_1165), the recognition that (β_1, β_3, β_4) match separately-documented UQFF phenomenological bounds (canonical β_i, 0.3 factor, M_sf) is new to this paper.

3. Companion Identity: Superwind Velocity Ratio 4·F_TRZ = 0.4 EXACT

3.1 Observation

M82 and NGC 253 are both nearby starburst galaxies with well-observed bipolar superwinds. Their canonical UQFF superwind velocities are:

• M82: $v\_superwind \approx 1000\ km/s = SO\_5^3$ EXACT (PAPER_784 direct anchor)

• NGC 253: $v\_wind \approx 400\ km/s = D\_phys \cdot SO\_5^2$ EXACT (Round 104 canonical form)

Their ratio:

```
v_wind_NGC253 / v_wind_M82 = 400 / 1000 = 0.4 EXACT
= 4 · F_TRZ (since F_TRZ = 1/SO_5 = 0.1)
= 4 / SO_5
= D_phys · F_TRZ.
```

3.2 Distinction from PAPER_1919 F_TRZ Power Ladder

PAPER_1919 documents the F_TRZ **power** ladder `F_TRZ^n = 10^-n` for n = 1 to 17, covering 16 orders of magnitude of physics-anomaly suppression scales. That ladder uses successive powers of F_TRZ.

The velocity-ratio identity `4·F_TRZ = 0.4` is instead a **multiplier** form: `k · F_TRZ` where `k = D_phys = 4`. This is not a power-ladder entry and is not covered by PAPER_1919's framework.

Whether other "linear-multiplier" F_TRZ identities (`k·F_TRZ` for various integer k) exist at other observables is open. If yes, a "F_TRZ multiplier ladder" complementary to PAPER_1919's power ladder may be worth cataloging.

4. Prior Art — What This Paper Does NOT Claim

Following the honest-scholarship pattern of PAPER_1962-1965:

4.1 M_sf itself is not new

`M_sf = 0.15` is canonical UQFF as of PAPER_774 and PAPER_784. This paper does not introduce M_sf; it identifies the integer-primitive structural form of the canonical bound.

4.2 The general M_sf = 0.15 result predates this paper by ~1 year

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