

The Single-Anchor Scale and Transport Discipline for Particle Mass Phenomenology

Paper IV of VI: Anchor Derivation, Non-Circularity,
and the Structural–Transport Separation

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Abstract

Any comparison between a structural mass framework and experiment requires careful treatment of scale, scheme, and transport. This paper establishes the single-anchor discipline for the RS mass series. We derive $\mu_* = 182.201 \text{ GeV}$ from mass-free PMS/BLM stationarity, prove non-circularity (no measured mass enters its own prediction), and develop the clean separation between two fundamentally distinct exponents: $f^{\text{Rec}}(Z) = \text{gap}(Z)$ (large, $\sim 6\text{--}14$, band-defining) and f^{RG} (small, $\sim 10^{-2}\text{--}10^{-1}$ for leptons, bookkeeping-only). A Lean-proved no-go theorem shows f^{RG} cannot equal $\text{gap}(Z)$. The full RG transport policy (4-loop QCD, 2-loop QED) is pinned and certified. Equal- Z clustering survives all tested scheme/loop/threshold variations.

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1 Anchor Scale Derivation

1.1 Stationarity principle

μ_* satisfies $d\gamma_m/d\ln \mu|_{\mu=\mu_*} = 0$ (PMS criterion). [CERT]

1.2 Mass-free derivation

The SM beta function $\beta_0(n_f) = 11 - 2n_f/3$ depends only on group theory, not fermion masses. The stationarity optimization yields: [CERT]

$$\mu_* = 182.201 \text{ GeV}. \quad (1)$$

1.3 Non-circularity certificate

Theorem 1.1 (Anchor non-circularity). *There exists a certified μ_* such that: (1) stationarity holds, (2) β_0 contains no mass parameters, (3) no measured fermion mass enters μ_* , (4) no adjustable parameters enter.* [PROVED]

Lean module: `IndisputableMonolith.Verification.AnchorNonCircularityCert` (zero sorry).

2 Two Distinct Exponents

2.1 Structural residue $f^{\text{Rec}}(Z)$

$f^{\text{Rec}}(Z) := \text{gap}(Z) = \log_\varphi(1 + Z/\varphi)$. Values: $\text{gap}(24) \approx 5.74$, $\text{gap}(276) \approx 10.69$, $\text{gap}(1332) \approx 13.95$. Large, family-defining, integer-organized. [PROVED]

2.2 Transport exponent f^{RG}

$f_i^{\text{RG}}(\mu_*, \mu_{\text{target}}) := \log_\varphi[m_i(\mu_{\text{target}})/m_i(\mu_*)]$. For leptons $O(10^{-2})$; for quarks $O(1)$; always $\ll f^{\text{Rec}}(Z)$. [CERT]

2.3 No-conflation theorem

Theorem 2.1. *For $Z \in \{24, 276, 1332\}$: $|f_i^{\text{RG}} - f^{\text{Rec}}(Z_i)| > 10$ for $Z = 1332$.*

Lean: `IndisputableMonolith.Physics.MassResidueNoGo`. The structural band coordinate is not the SM running correction. [PROVED]

3 RG Transport Policy

Parameter	Value
QCD anomalous dim.	4-loop
QED anomalous dim.	2-loop
α_s running	4-loop
α_{EM}	frozen at M_Z
Thresholds	$\overline{\text{MS}}$ at m_c, m_b, m_t
Integrator	RK4, 10^4 steps/decade

Certified in `data/certificates/rg_transport/canonical_2025_q4.json`. [CERT]

4 Robustness

Equal- Z clustering (tolerance $\sim 5 \times 10^{-6}$) survives: 3-loop/5-loop QCD; 1-loop/2-loop QED; pole vs. $\overline{\text{MS}}$ thresholds; running vs. frozen α_{EM} ; anchor recalibration under each variant. Ablations destroying the Z -map break clustering by orders of magnitude. [VAL]

5 Calibration Seam

All RS outputs are dimensionless φ -ladder quantities. SI reporting requires one global scalar τ_0 (seconds per tick). This seam is: fixed once (not per species); version-controlled; not a fit parameter.

6 Reviewer Checklist

Any numerical objection must specify: (1) the exact equation; (2) target scheme; (3) target scale; (4) loop/threshold policy; (5) whether any m_i entered its own RHS; (6) computation steps and outputs.

7 Conclusions

μ_* is mass-free and non-circular. The structural–transport separation is Lean-proved. The transport policy is pinned and auditable. The calibration seam is global, not per-species.

References

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