Note: In this document, α refers exclusively to the fine-structure constant (α-in) used as input for calibration. The symbols β and γ refer only to standard Post-Newtonian (PPN) parameters relevant to external validation protocols. No structural potential terms {α_V, β, γ} appear in this document.

Limitations & Validation Plan — Structural Field Theory (SFT)

Purpose. This note consolidates current limitations of SFT and the corresponding validation plan. It is written as a self-contained section to be included in the manuscript bundle.

1) Experimental validation is pending

Concern. While SFT makes concrete predictions, direct tests (e.g., sub-millimeter torsion measurements; CMB/FRB birefringence) are not yet completed.

Response. We treat this as an opportunity and commit to a short, testable roadmap:

- **(i) Static Coulomb calibration (α-in): use α_ref as INPUT for calibration; report only consistency with α_ref. Any α-out estimation, if executed, lives in a pre-registered appendix with a PASS/FAIL threshold (e.g., τ = 1%) and does not affect RC validity.**
- **Astrophysical cross-checks.** Recast SFT's birefringence/dispersion predictions against existing CMB TB/EB bounds and FRB/GRB polarization catalogs; declare pass/fail criteria ex ante.
- **Quantitative acceptance bands.** For each test we publish numerical thresholds (energy conservation $\Delta E/E$, phase‑speed dispersion $|v_{phase}-c|/c$, PPN γ,β), so that third parties can reproduce and decide independently.

2) Scope relative to the Standard Model is limited (for now)

Concern. Weak interactions, flavor, and the full hadronic spectrum are not modeled yet.

Response. SFT's present claims are deliberately scoped to the EM+gravity sector and to the emergent spin-½ route. The extension path is explicit:

- **Dirac/Wilson appendix completion.** Add numerical checks (no doublers, γ5‑hermiticity, convergence) with tolerances.
- **Internal-texture routes to non-Abelian structure.** "Route B" remains historical/optional, not required for the mainline; we will report negative results as such.
- **Scope discipline.** Until the above milestones are met, we avoid over‑reach and label out-of-scope items as future work.

3) Initial calibration may look like tuning

Concern. The three‑step calibration of $q^*, \hbar^*, \varepsilon^*, \mu^*$ could be perceived as parameter‑tuning.

Response. We operate a single-pass calibration pipeline (already stated across the corpus): calibrate emergent scales once from {α_em, c} via a static Coulomb test, freeze them, and then run all demonstrations without per-observable retuning. To make this audit-proof we will:

- **Leave-one-out stress test.** Drop α_em from calibration → predict it back; report residual.
- **Traceability table.** Each figure/number lists precisely which frozen scales it consumes. This turns "tuning" into a reproducible metrology step with cross-validation, rather than free fitting.

4) Discrete vs. continuum tension

Concern. Even with a clean continuum limit, discreteness can jar with traditional QFT/GR.

Response. Our mainline Lagrangian is Lorentz-invariant in the continuum; discretization induces $O((a k)^2)$ corrections that we measure and report (slope $\xi/2$ in the dispersion-fit). We provide: (I) a convergence scan in a (2nd-order as claimed); (II) an explicit gauge-fixed Noether construction showing that the Maxwell sector carries no extra DOF (A is a functional of S + lattice operators). This reframes discreteness as a numerical regularization with controlled systematics, not as an alternative kinematics.

Reviewer Checklist (one page)

1. **Build & Repro:** Docker image builds; pytest passes.
2. **Calibration:** Run once, record q^*, $\hbar^*$, ε^*, μ^*; no retuning afterward.
3. **Numerics:** Report $\Delta E/E \leq 1e{-}3$; continuity residual $\leq 1e{-}4$; dispersion error $\leq 1\%$.
4. **PPN:** State convention (signature $-,+,+,+$, S = $-$U), show $\gamma = 1$ (linear), and $\beta = 1 + c\_\beta\, \lambda_4 + O(\lambda_4^2)$ with the DSM protocol to extract c_β.
5. **EM emergence:** Cite the Noether→Maxwell pipeline and uniqueness/gauge‑fixing note (no extra DOF).
6. **Scope:** Label weak/flavor/hadrons as future work; list milestones and negative‑result policy.
7. **Experiments:** Define pass/fail bands for (i) sub‑mm torsion, (ii) CMB/FRB birefringence, (iii) lab dispersion.

Cross‑links. See Integrated Technical — Unified Notation & Units (PPN convention), Appendix B (Emergent EM from S), and the Simulation Supplement (Reproducibility summary; defaults; checklist).

Reviewer Checklist — language guardrail: use labels (C) calibrated / (P) prediction; avoid "predicts/reproduces α" wording in the RC body.