Note: In this document, α refers exclusively to the fine-structure constant (α-in), used for initial Coulomb calibration. The symbols β and γ appear only in the context of Post-Newtonian (PPN) parameters. No structural potential terms {α_V, β, γ} are used in this document.

SFT — Statement for Reviewers (EN)

Statement.

We present the Structural Field Theory (SFT) as an emergent, testable hypothesis with deliberately scoped claims: electromagnetism + gravity and the emergence of spin-½ from a single structural field. The package ships with Docker and automated checks (pytest), so third parties can reproduce and inspect results independently.

Calibration discipline. In this RC, α_em is INPUT (α-in); any α-out exercise, if performed, is reported separately and does not affect RC validity.

We run a single-pass calibration of the emergent scales (q^*, $\hbar^*$, ε^*, μ^*) from {α_em, c} using a static Coulomb test, then freeze these scales. All demonstrations are executed without per-observable retuning. This turns "tuning" into reproducible metrology.

Quantitative validation.

The code includes numerical metrics: energy conservation $\Delta E/E$ (target $\leq 10^{-3}$), phase-speed dispersion (target ≤ 1%), and an automated g-factor check around the expected value (tolerance window given). For gravity, we adopt explicit PPN conventions (signature −,+,+,+, bridge $S = -U$) to avoid ambiguities.

Continuum vs. lattice.

The continuum Lagrangian is Lorentz-invariant; discretization introduces controlled $O((a\,k)^2)$ corrections that we measure and report via convergence scans. The Noether-to-Maxwell construction is stated with gauge-fixing and no extra DOF.

Scope & next steps.

We do not claim a full Standard Model account. We list milestones instead: (I) completing Dirac/Wilson numerics (no doublers, γ_5-hermiticity, convergence); (II) extended convergence/AMR studies; (III) near-term lab tests and astrophysical cross-checks with pre-declared pass/fail bands. In short, SFT offers a short path to validation or falsification: executable code, frozen calibration, and quantitative acceptance criteria.

Reviewer Quick Start (5-min) — SFT (patched)

This patch keeps the original structure and adds: (I) a **Quick Audit Table** *with PASS/FAIL thresholds, (II) a* **Reviewer Checklist** *you can tick off, and (III) a tiny* **Conventions** *box to avoid ambiguities.*

0) Quick requirements

Option A — Local Python (recommended for the quick start):

```
python3 -m venv .venv && source .venv/bin/activate
```

```
pip install -U numpy pandas scipy matplotlib pytest
```

Option B — Docker (encapsulated environment):

```
# From the docker/ directory of the unified package
```

```
docker build -t sft-min-valid:0.9 .
```

docker run --rm -v $PWD:/work -w /work sft-min-valid:0.9 python scripts/generate_smoke_artifacts.py

1) Synthetic EOC (CPU-only) — order ≈ 2 ⇒CI “ok”

Goal: verify in ~minutes that the numerical pipeline passes a synthetic convergence test (no GPU required).

```
# Inside the Doc 6 (EOC) bundle
```

```
python test_eoc_ci_v2.py  # reads EOC_synthetic.csv and produces
plots/statistics
```

Expected PASS: slope p ≈ 1.8–2.0 (95% CI within [1.70, 2.05]) and $R^2 \geq 0.995$. Artifacts: eoc_loglog_ci_v2.png, error_vs_N_ci_v2.png, JSON summary.

2) Venus perihelion (synthetic series) — slope ≈ 8.62″/century

Goal: validate the fitting pipeline with a manifest and PASS/FAIL criteria.

```
# Inside venus_perihelion_bundle/
```

```
python verify_venus.py --csv varpi_series_venus.csv --manifest
manifest_venus.json
```

Expected PASS: |slope_fit − 8.624984| ≤ 0.2 arcsec/century and $R^2 \geq 0.999$. Artifact: perihelion_venus_report.json (slope, R^2, PASS/FAIL).

When you have real solver data (overlay):

```
# Inside venus_real_pipeline_overlay/

python extract_varpi.py --csv orbit_venus_state.csv

python verify_venus_real.py --report perihelion_venus_real_report.json
--manifest manifest_venus_real.json
```

Report slope in arcsec/century and R^2; PASS/FAIL via manifest.

3) Emergent spin-½ — FR (2π) + j(j+1) spectrum

Goal: check the two operational signatures of spin-½.

3.1 Rotational spectrum (fast):

```
# In the SPIN package

python spin_pipeline.py \

  --levels_csv spin_spectrum_levels.csv \

  --grid_id EXAMPLE_64^3 --L 64 --dx 1.0 --seed 12345
```

Expected PASS: $R^2 \geq 0.98$ and first level j = 1/2. Artifacts: spin_spectrum_summary.csv (or *_merged.csv), spin_provenance.json, checksums_SHA256.txt.

3.2 Overlap-phase (FR, 2π) — optional if you have overlaps.npy:

```
# overlaps.npy contains the <ψ_{k+1}|ψ_k>

python spin_pipeline.py --overlaps overlaps.npy --grid_id 64^3 --L 64 -
-dx 1.0 --seed 12345 --K 128
```

Expected PASS: $|\text{phase} - \pi| \leq 0.1\pi$ (recorded in spin_overlap_results.csv).

You can also review pre-generated summaries:
- spin_PASS_FAIL_summary.json (marks PASS/FAIL for FR and the spectrum)
- spin_levels_zero_intercept_on_excitations_summary.json (fit with zero intercept on excitations)

4) (Optional) CPU-only smoke test

```
# Inside SFT_fallback_bundle/

python scripts/generate_smoke_artifacts.py

# or use build/tce_simulator when available for your platform
```

5) What to include if something fails

Attach the CSV/JSON produced at each step (e.g., perihelion_venus_report.json, spin_spectrum_summary.csv, spin_PASS_FAIL_summary.json) and checksums_SHA256.txt. Specify commit/version and seeds (they appear in the provenance JSON).

6) Quick Audit Table (added)

Claim	Script / Artifact	Metric	PASS/FAIL threshold	Notes
Energy conservation	pytest::energy_conservation	$\Delta E/E$	$\le$ 1e−3	Same mesh across runs; report seed & BC.
Dispersion (continuum↔lattice)	dispersion_scan.py	max $\lvert\omega/(ck)-1\rvert$	≤ 1 %	Also report linear fit slope vs. $(ak)^2$.
g-factor (electron)	calc_gfactor.py	g	2.0022 ± 3e−4	Scale-free ratio; vary B_test to confirm linearity.
PPN (γ, β)	ppn_check.py	γ, β	γ = 1 ± 1e−5; $\lvert\beta-1\rvert \le$ 1e−4	Convention (−,+,+,+), S ≡ −U.
Spin-½: spectrum	spin_pipeline.py --levels_csv ...	R^2 of E vs j(j+1)	$R^2 \ge 0.98$	First level j = 1/2 required. Fit on excitations (E−E0) with zero intercept.
Spin-½: FR (2π)	spin_pipeline.py --overlaps ...	$\lvert$phase−π$\rvert$	≤ 0.1π	Optional if overlaps

				available.
Venus (synthetic)	verify_venus.py	slope (″/century)	|slope−8.624984| ≤ 0.2 & R^2 ≥ 0.999	Use provided manifest.
Double-slit (optional)	double_slit_phase.py / double_slit_visibility.py	phase R^2; visibility	R^2 ≥ 0.98; monotonic (tolerate ≤1 local up-tick < 1% as noise); saturation gap ≤ 0.10	Report both phase slope and visibility curve.

Tip: keep α-in frozen after Coulomb (q*, ħ*, ε*, μ*). No per-observable retuning.

7) Reviewer Checklist ☑ (added)

[ ] Environment ready (venv or Docker) · hashes verified (SHA-256).

[ ] α-in frozen after Coulomb (q*, ħ*, ε*, μ*) · no observable-specific retuning.

[ ] EOC synthetic: p in [1.70, 2.05] and $R^2 \geq 0.995$ · PASS.

[ ] Dispersion: max $|\omega/(ck)-1| \leq 1$ % · slope vs $(ak)^2$ reported.

[ ] g-factor: mean 2.0022 ± 3e−4 · μ(B) linear, runs agree across grids.

[ ] PPN: $\gamma \approx 1$, $|\beta-1| \leq$ 1e−4 using the same lagrangian params as micro.

[ ] Spin spectrum: $R^2 \geq 0.98$ · first level j = 1/2.

[ ] FR (2π): $|\text{phase}-\pi| \leq 0.1\pi$ (if overlaps provided).

[ ] Venus (synthetic): |slope−8.624984| ≤ 0.2 and $R^2 \geq 0.999$.

[ ] (Optional) Double-slit: phase $R^2 \geq 0.98$; visibility monotonic; saturation gap ≤ 0.10.

[ ] Provenance attached: CSV/JSON + checksums_SHA256.txt + seeds.

8) Conventions & notes (added)

PPN convention: signature (−,+,+,+), Poisson $\nabla^2 U = -4\pi G\rho$, and S ≡ −U in the weak-field map.

Continuum vs lattice: expect $O((ak)^2)$ corrections; report the slope from the dispersion fit.

Electromagnetism (emergent): A^μ[J(S)] solved in Lorenz gauge; continuity in the discrete calculus must hold exactly (test included).

9) Troubleshooting (added)

• R^2 slightly below threshold (spin or Venus): check the CSV ordering, outliers, and units; re-run with the provided manifest/seed.

• Visibility > 1 or < 0: clip to [0,1] in the reporting stage only, keep raw data intact.

• PPN mismatch: verify the convention (signature, $S \equiv -U$) and that the same parameter set is used for micro and macro tests.

Appendix — Last-Mile Inserts for Doc 9 (v1.0.0)

Ready to paste; preserves original conventions and adds JSON artifacts for QA/Reproducibility.

A. PPN Extraction & QA

A.1 Conventions

• Metric signature: (-,+,+,+) | Poisson: $\nabla^2 U = -4\pi G\rho$ | Bridge: $S \equiv -U$.

• Units for observables: deflection (arcsec), Shapiro (microseconds), perihelion (arcsec/century).

• Significant digits must be consistent with uncertainties (u) / 95% CI.

A.2 Route A — Metric fit (Φ_eff, Ψ_eff)

Use dimensionless $\phi \equiv U/c^2$. Model: $\Phi\_eff = a_1 \phi + a_2 \phi^2$, $\Psi\_eff = c_1 \phi$.

Derived parameters: $\gamma = c_1/a_1$, $\beta = 1 + a_2/a_1^2$. Propagate errors from the fit covariance (delta method).

QA thresholds (suggested): $|\beta-1| \le 1e-4$, $|\gamma-1| \le 1e-4$, perihelion residual ≤ 0.2 arcsec/century.

Artifact: PPN_RESULTS.json (schema v1.0.0). Required keys: schema_version, route="A", conventions, fit, derived, qa, provenance, timestamp.

A.3 Route B — Observables fit

Fit observables directly (WLS recommended if heteroscedastic). Perihelion uses standard GR kernel K(a,e,M) for the Newtonian baseline.

Light deflection and Shapiro enter as complementary constraints with uncertainties. Bootstrap (e.g., 2000 resamples) for CI95 on (a_1,c_1,a_2) and propagate to (β,γ).

Optional gate: GR slope ∈ CI95% for perihelion.

Artifact: PPN_RESULTS.json with route="B" and block observables_fit.

A.4 Reporting & Reproducibility

Include seed, commit, calibration_hash, manifest path, and any artifacts_sha256 (CSV/plots). State Docker tag or requirements lock.

B. Energy Accounting & Collapse Ledger

B.1 Discrete energy (compatibility with the solver)

Operators: time-difference D_t (leap‑frog); spatial differences ∇_e (co‑staggered, central). BC: periodic (state otherwise if different).

Components: kinetic, gradient, potential, EM (if applicable), and total. Collapse ledger: when nodes are frozen, book removed energy as E_collapse.

B.2 Conservation & diagnostics

Report ΔE and ΔE_rel including E_collapse when ledger is enabled.

Continuity residual: L2 and Linf norms of the discrete continuity equation.

Pass criterion example: ΔE_rel ≤ 1e−3.

B.3 Artifact: ENERGY_REPORT.json (schema v1.0.0)

Required keys: schema_version, integrator, grid, units, components (t0, tN), collapse_ledger, conservation, continuity_residual, discretization, provenance, timestamp.

B.4 AMR notes

When AMR is on, document subcycling and flux synchronization; compute diagnostics on the composite hierarchy.

C. Review Cross-check (RC) Table — Skeleton

Fill one row per claim/test. Use consistent units.

Test	Dataset/Run	Metric	Threshold	Result ± u	Seeds	Artifacts (CSV/PNG/JSON)	SHA−256	PASS
Venus perihelion (PPN)	manifests/venus_ppn_A.json	slope (arcsec/century)	≤ 0.2 from GR; GR∈CI 95% (opt)	8.6249 ± 0.020	12345	results.csv, fig.png, PPN_RESULTS.json	…	✔

Light deflection	synthetic solar rim	θ (arcsec)	1.750 ± 0.003	1.750 ± 0.003	—	plot.png	...	✔
Shapiro delay	superior conjunction	delay (µs)	248.0 ± 0.8	248.1 ± 0.7	—	plot.png	...	✔
SPIN (FR loop)	spin/run_64^3_seed777	phase(2π)	|phase−π| ≤ 0.1π	0.98π ± 0.02π	777	phase.csv, fig.png	...	✔
Rotor spectrum	spin/spectrum_64^3	R^2 (fit j(j+1))	≥ 0.98	0.989	777	levels.csv, fit.png	...	✔
Double-slit	slit/manifest.json	phase R^2; visibility	R^2 ≥ 0.98; monotone	0.992; monotone	4242	trace.csv, fig.png	...	✔
EOC (synthetic)	eoc/EOC_synth.csv	slope p; R^2	1.70–2.05; ≥0.995	1.87; 0.9988	123	eoc.csv, eoc.png	...	✔
Energy conservation	energy/run_96^3	ΔE_rel	≤ 1e−3	2.1e−4	555	ENERGY_REPORT.json	...	✔

D. How to link from the main text

• In the Quick Start, end each step with: “See Appendix A/B/C for the JSON artifact format and QA thresholds.”

• In the Quick Audit Table, add a column “Artifact” and link to the JSON files produced by each step.

• In Troubleshooting, mention signature/units and the S≡−U bridge (Appendix A.1) and the energy ledger (Appendix B).

E. Change log

v1.0.0 — Initial appendix covering PPN (routes A/B), energy accounting + ledger, and RC Table skeleton. Ready for external reviewers.

Structural Field Theory. Complete theory, documents and runners at: https://github.com/Xaquer69/sft-theory-and-runners

https://doi.org/10.5281/zenodo.17608314