

**Thesis:** All observables are manifestations of a single phenomenon—microscopic tensional distortion of S.

**Definition (Ontology):**

There is one underlying phenomenon—**structural micro-distortion of S**—whose **localized, topological, and propagating configurations** realize all observed entities and interactions. Mass, spin, charge, gauge-like behavior, and gravitational response are **manifestations of tensional geometry and its evolution**, not independent postulates.

**Modeling stance:**

We use a **single scalar structural field** as the minimal, continuous–discrete *bookkeeping device* for this phenomenon (for simulation, calibration, and proofs). The scalar model is thus a **map of the phenomenon**, not the phenomenon itself.

**Corollaries (to prevent misreadings):**

- There are **not multiple fundamental forces** added by hand; there is **one medium and one dynamics** whose compatible modes manifest as different forces.
- “Particles” are **persistent, quantized distortion patterns** (e.g., helicoidal/solitonic states), not extra substances.
- “Fields” in the usual sense are **effective descriptions** of interaction patterns generated by the same micro-distortion.
- Calibration choices (e.g.,  **$\alpha$ -in**) fix units; they do not introduce additional ontic elements.

**What SFT is *not* claiming:**

- Not that “a scalar field is the only thing that exists.” The scalar is a **descriptor**; the **distortion is the ontic entity**.
- Not that discretization creates the physics. The lattice is a **numerical scaffold**; the physics is the **phenomenon**, which admits a continuum limit.
- Not that we assume the Standard Model by fiat. **Standard features** (charges, spectra, couplings) **must emerge** as constraints of tensional compatibility and topology.

The corpus adopts a single-pass calibration ( $\alpha$ -in) and propagates the same parameter set through all staged validations. Each runner produces: (I) compact JSON with thresholds and verdicts; (II) SHA-256 manifests (including self-hash); (III) seed provenance. This design minimizes degrees of freedom and maximizes external auditability.

## Abstract

*We present Structural Field Theory (SFT), a unified discrete–continuous framework in which quantum and relativistic phenomena emerge from the dynamics of a single **underlying phenomenon**—the microscopic tensional distortion of a structural medium—**modeled** via a scalar structural field.* In this formulation, space is modeled as an elastic lattice supporting solitonic excitations, collapse processes, and long-range stress gradients that mimic fundamental particles and interactions. The framework is calibrated using the fine-structure constant ( $\alpha$ , treated as input), while all other quantities arise from internal consistency and numerical evolution.

We report quantitative validations across multiple physical domains. At the microscopic scale, simulations reproduce electron-like soliton signatures, g-factor ( $2.003 \pm 0.004$ ) (P), Coulomb’s law, and the spin- $\frac{1}{2}$  signature via both Finkelstein–Rubinstein  $2\pi$  phase inversion and rigid-rotor  $j(j+1)$  spectra ( $R^2 \geq 0.99$ ). Radial solvers recover hydrogen and tritium energy levels with meV-level isotope shifts. At macroscopic scales, the theory reproduces classical relativistic tests: Mercury’s perihelion ( $\approx 43''/\text{century}$ ) and Venus’ perihelion advance  $\Delta\varpi$  ( $8.625 \pm 0.020''/\text{century}$ ), both in agreement with General Relativity, as well as PPN parameters. Synthetic and real pipelines are provided for reproducibility, including CPU-only smoke tests, GPU-based solvers, and Docker environments with complete provenance, manifests, and SHA-256 checksums.

We also outline SFT’s present limitations (incomplete embedding of the full Standard Model content; possible discretization artifacts; and reliance on an  $\alpha$ -in calibration discipline) and we state falsifiable predictions: (I) high-k modified dispersion (stringent tests of Lorentz invariance), (II) sub-mm Yukawa-like deviations in gravity, (III) cosmic birefringence, and (IV) the onset of nonlinear Breit–Wheeler pair production mapped in strong-field parameters ( $a_0, \chi, \gamma$ ) rather than a single intensity threshold. Together, these results establish SFT as a reproducible, falsifiable program that bridges lattice field simulations with quantum and relativistic observables.

We report  $\beta = 1.000 \pm 1.0 \times 10^{-4}$  and  $\gamma = 1.000 \pm 1.0 \times 10^{-4}$  (95% CI), consistent with GR; see procedure in Doc 4.

Language guardrail: mark figures/tables as (C) calibrated or (P) prediction;  $\alpha$  is treated as input ( $\alpha$ -in);  $\beta, \gamma$  are reserved for PPN; the structural potential uses  $\{\alpha_V, \lambda_4, \lambda_6\}$ .

> “The reader should keep in mind that all physical phenomena addressed in this corpus—from the electron’s g-factor to Mercury’s perihelion precession, including quantum interference and structural collapse—are not postulated as separate entities. They are local expressions of a single phenomenon: the tensional distortion of the structural medium, **tracked by the scalar descriptor**  $S(\mathbf{r}, t)$ . This distortion, through its geometry and dynamics, gives rise to what we conventionally call mass, spin, charge, gravity, or time. **We do not postulate** multiple fundamental forces; there is one medium and one dynamics whose compatible modes **manifest as** different forces.”

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Observed Phenomenon   Structural Manifestation of $\backslash(S\backslash)$		
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Mass	Local tensional density	
Spin	Helicoidal geometry of S	
Electric charge	Structural asymmetry in collapse	
Gravity	Sum of tensions across the mesh	
Time	Structural frequency	
Quantum interference	Tensional superposition	

> “The stability of a configuration is not intrinsic to the object, but emerges from its tensional compatibility with the medium.”

## —Document 0: Orientation and Structure of the SFT Corpus

Cross-links: DSM → 2\_SFT\_Discrete Structural Model (DSM); PPN Summary → 4\_Quick\_Summary\_with\_figures\_with\_PPN\_integration.docx; Simulation Supplement → 3\_SFT\_Simulation\_Supplement.

This introductory note provides readers and reviewers with a roadmap of the complete Structural Field Theory (SFT) package. The corpus is intentionally modular: each component addresses a different layer of the framework, from theoretical foundations to numerical validation and reproducibility infrastructure.

- Core Foundations (Docs 1–2): Glossary and discrete structural model, defining notation, calibration policy ( $\alpha$ -in), and the basic lattice dynamics.
- Simulation Supplement (Doc 3): Numerical schemes (leap-frog, AMR, CFL stability), collapse protocols, and first-principle simulations of electron-like solitons, double-slit behavior, and Coulomb interaction.
- Quick Summary / Draft Paper (Doc 4): Condensed manuscript presenting headline results (g-factor, perihelion shift, PPN compatibility).
- Integrated Technical Report (Doc 5): Comprehensive reference unifying notation, derivations, validation checklists, and reproducible protocols.
- Validation Appendices (Docs 6–7): Synthetic convergence tests (EOC), radial hydrogen/tritium solvers, and Venus perihelion overlays.
- Limitations and Validation Plan (Doc 8): Transparent recognition of scope and a roadmap

for falsifiable predictions.

- Reviewer Argument (Doc 9): A concise statement addressing common objections ( $\alpha$  tuning, discretization, scope).
- Bundles and Pipelines (ZIPs): Unified release with Docker, configs, scripts, datasets, and fallback smoke tests for CPU-only environments.
- Spin Packages: Independent validation of spin- $\frac{1}{2}$  signatures via FR phase and rigid-rotor spectra.
- Reviewer Quick Start: A 5-minute guide enabling reviewers to reproduce core results with minimal setup.

Readers should therefore expect: (I) a coherent theoretical proposal; (II) quantitative results spanning atomic to orbital scales; (III) a reproducible software and data ecosystem; and (IV) an explicit plan for validation and falsification. This orientation document (“Doc 0”) should be read first, before proceeding to the technical reports.

## Addendum — Consistency Notes

- We use  $\varphi \equiv \mathbf{U}/c^2$  (dimensionless) and  $\mathbf{S} \equiv -\mathbf{U}$  as consistent notation across the corpus.
- Convention:  $\Delta\varpi_{\text{Venus}} = 8.625 \pm 0.020''/\text{century}$  (golden path); all reported figures are harmonized to this value.
- Tagging (C)/(P): example —  $\Delta\varpi$  of Venus (C); CMB birefringence (P).

## Quick Verify — Where is each claim checked?

- Electron g-factor → Docs 5 and 7 (artifacts and SHA-256).
- PPN ( $\beta, \gamma$ ) and Venus perihelion → Docs 4 and 7 (PPN\_RESULTS.json).
- $H/{}^3H$  (radial a.u.) → Doc 7 (Table E, virial, normalization).
- Reproducibility (EOC/CI, energy/continuity) → Docs 6 and 5 (ENERGY\_REPORT.json).
- Double slit (phase and visibility) → Doc 7 (manifest + traces).

## Ontological scale — one grid for micro & macro

- $\Delta x$  is a numerical regulator, not a physical grain. SI units come from a single-pass calibration of  $\{q^*, \hbar^*, \varepsilon^*, \mu^*\}$  ( $\alpha$ -in), and the same Lagrangian governs both regimes.

- We report scale-invariant, locally extracted coefficients (e.g., PPN  $\gamma=c1/a1$ ,  $\beta=1+a2/a1^2$ ) and dimensionless ratios (e.g., g-factor). These do not depend on the absolute cell size as long as  $ak \ll 1$  (continuum regime).
- Multiscale arises from intrinsic field lengths (core size, Yukawa tail, etc.), not from  $\Delta x$ . AMR increases dynamic range but does not retune physics.
- We decouple numerics from physics via dispersion fits ( $\omega/(ck)=1+\xi(ak)^2+\dots$ ), EOC/GCI across 3 grids (target  $p\approx 2$ ), and energy/continuity budgets (with a collapse ledger when freezing is active). Observables are quoted only once grid-independence is reached.

### Thermal decoherence — what we test

- Phase dynamics under a thermal bath is modeled by a Langevin process with FDT:  $\text{Var}[\varphi](t)=2D\theta t$ ,  $D\theta\propto\gamma k_B T/\hbar^*$ . Visibility decays as  $V=\exp[-D\theta(T) t]$ .
- At fixed grid,  $\ln V$  is linear in  $T$  and in path length/time-of-flight; at fixed  $T$ ,  $V$  is grid-independent in the converged regime. This cleanly separates physics ( $T$ ) from numerics ( $\Delta x$ ).
- Artifacts: DECOHERENCE.json ( $T$ ,  $\gamma$ ,  $\hbar^*$ ,  $V$ , CI, seed, SHA-256), plus the usual ENERGY\_REPORT.json to certify conservation/continuity. Suggested gates:  $\text{slope}_T > 0$  for  $\ln V$  vs  $T$ ; mesh-independence at fixed  $T$ .

### RC Table — additions (for reviewers)

- Mesh scaling & dispersion → Docs 5–6 (dispersion fits with  $\xi\approx -1/12$ ; EOC/GCI  $p\approx 2$ ; ENERGY\_REPORT.json).
- Thermal decoherence → Doc 7 (Appendix—Decoherence) with DECOHERENCE.json and figures  $\ln V$  vs  $T$  and length.

## Master Index — Extended (Docs 10–14)

### 10 — Appendix A-OUT (v0.3): Alpha-Out (non-circular)

1. Purpose: Estimate  $\alpha$  without using  $\alpha$  in calibration. CPU-friendly pipeline:  $c$  (dispersion, small- $k$ ) →  $\hbar^*$  (rotor) →  $\{q^*, \epsilon^*\}$  (Coulomb) →  $\hat{\alpha}$  with uncertainty.
2. Inputs → Outputs: dispersion.csv, rotor\_energy.json, coulomb\_profile.csv → ALPHA\_OUT.json (value, u95, tier) + HBAR\_FROM\_ROTOR.json, Q\_EPS\_SOLUTION.json.
3. Tiers/Gates: Tier-1 (1%), Tier-2 (100 ppm), Tier-3 ( $1e-5$ – $1e-6$ ). Saves small- $k$  indices, robust fit method, and full provenance (commit, versions, hashes).
4. Status: Reviewer-ready (appendix-only; not part of the core RC).
5. ZIP runner: alpha\_out\_runner\_pack.zip (README, MANIFEST, verify.py, checksums).

## **11 — One-Pager: Designed Matter via Tensional Compatibility (SFT)**

6. Purpose: One-page landing for reviewers/collaborators/sponsors: thesis, what you get, how to verify (ZIP + JSON + PASS/FAIL).
7. Contents: Tagline; “Who is this for / What you get”; runners with uniform primary gates; output routes (REGION provided vs. synthesized from SCAN + thresholds); mini-JSON examples with schema\_version; roadmap with clear “done” criteria.
8. Relations: Links to runner packs, the master validation table, and Appendix A-OUT for anti-circularity.
9. Status: Ready to share.

## **12 — Dialogue (English)**

10. Purpose: Plain-language narrative of the SFT stance (compatibility of the medium), aligned with the RC: preserves SM predictions, reframes mechanism.
11. Reviewer hooks: Adds falsifiability pointers (dispersion  $O((ak)^2)$ , sub-mm Yukawa, null optics, existence scans) and directs to runner packs for PASS/FAIL evidence.
12. Use: Executive/explanatory; no numeric claims beyond what the RC and runners certify.

## **13 — atomX: Step-by-Step Recipe (PASS-ready, amended v1)**

13. Purpose: Worked example of an existence runner with reproducible thresholds and non-circular verdicts (natural vs maintained).
14. Gates: split\_thr=0.19 meV, compat\_thr=0.02, r2\_thr=0.98; natural requires PASS without controls; maintained requires ablation FAIL when removing controls.
15. Artifacts: EXISTENCE\_REPORT\_atomX.json, EXISTENCE\_REGION\_atomX.json, synthetic\_atom\_scan.csv, checksums\_SHA256.txt (schema-validated JSON; NaN/Inf→null).
16. ZIP runner: includes verify\_atomX.py (schema check, region rebuild from CSV, PASS mask match, checksum verification).

## **14 — Capstone (Unified v6c)**

17. Purpose: Consolidated code/standards manual for reviewers: JSON policy (schema\_version, sanitize), MANIFEST policy (checksums with self-hash), helpers (json\_sanitize, thresholds.propagate\_thresholds, verdicts.compute\_verdict, lifetime.tau\_with\_ci, units.provenance\_scale\_setting), and runners v1.0.3 (leptons, quarkonia, CKM, strong nulls, jitter, LOO).
18. External validation: CSV schemas, copy/paste commands, and reminders of  $\alpha$ -in discipline (see atomX recipe).
19. Note: make\_region\_from\_scan must rebuild PASS mask from the scan CSV using declared thresholds (placeholder noted in comments), (see atomX for reference).

## **Cross-References — How to Read (Additions)**

20. (→ Doc 10) Questions about predicting  $\alpha$  without circularity: see Appendix A-OUT (Doc 10). Results live in ALPHA\_OUT.json with uncertainty tiers; appendix-only (not part of the core RC).
21. (→ Docs 11–14) For a one-page overview and the review/implementation toolkit, see One-Pager (Doc 11); for pedagogical narrative see Dialogue (Doc 12); for a worked runner see atomX (Doc 13); for standards and code policy see Capstone (Doc 14).

## **Quick Verify — Additional Pointers**

22. Alpha-Out (non-circular) → Doc 10 (ALPHA\_OUT.json, provenance + tiers).
23. Existence runner (atomX) → Doc 13 (EXISTENCE\_REPORT/REGION; region rebuilt from CSV in verify\_atomX.py).
24. Standards & MANIFEST policy → Doc 14 (JSON sanitize, schema\_version, checksums with self-hash).

## **Consistency Notes (Additions)**

25. Manifest name & format: use checksums\_SHA256.txt with lines  
'HASH<sub>p</sub> RELATIVE\_PATH', plus a final self-hash line for the manifest itself.
26. Schema discipline: every new JSON includes schema\_version and passes schema validation (CI blocks otherwise).

## **Value of the Document**

This text is not a final answer, but it is an honest, structured, and falsifiable one. It acknowledges conceptual tensions, documents them, and proposes an empirical path to resolve them: GPU simulations capable of distinguishing between genuine unification and numerical artifact.