Falsification Pack

Quantitative Predictions of Category τ

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Abstract

Category τ is a mathematical framework built from 7 axioms on 5 generators. When its master constant $\iota_\tau = 2/(\pi + e)$ is calibrated against the neutron mass, the framework produces $\sim$220 quantitative predictions across particle physics, cosmology, nuclear physics, astrophysics, and fluid dynamics — with **zero free parameters**. This document collects all predictions in machine-checkable form: 25 at sub-100 ppm, $\sim$55 at sub-10,000 ppm, and $\sim$140 qualitative/structural. Each prediction is keyed to a registry ID tracing back to its derivation in the 7-book series. Five decisive tests (CMB-S4, DESI, LZ, JUNO, HL-LHC) can confirm or refute the framework by 2035.

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1 Methodology

1.1 One Constant, One Anchor, Zero Parameters

The entire prediction apparatus rests on:

1. **Master constant:** $\iota_\tau = \dfrac{2}{\pi + e} = 0.341304238875\ldots$, derived from the holonomy of the lemniscate boundary $\mathbb{L} = S^1 \vee S^1$.
2. **Calibration anchor:** The neutron mass $m_n = 939.565\,\text{MeV}$ fixes the overall energy scale. This is the *only* input from experiment.
3. **Derived constants:** $\kappa_D = 1 - \iota_\tau$, $\kappa_\omega = \iota_\tau/(1+\iota_\tau)$, $W_3(4) = 5$, $\kappa(C;3) = \iota_\tau^3/(1-\iota_\tau)$.

Every prediction below is a closed-form expression in these quantities. There are no fitting parameters, no adjustable couplings, and no phenomenological inputs beyond m_n.

1.2 Scope Labels

Every entry in the 4,547-entry registry carries a scope label:

- **Established:** Provable in classical mathematics (ZFC).
- **τ-effective:** Proven within the Category τ framework.
- **Conjectural:** Open or unproven; may be upgraded by further work.
- **Metaphorical:** Intuitive analogy only.

Scope labels are not marketing claims — they are machine-readable metadata attached to every result. The registry is publicly available.

1.3 Precision Tiers

Tier	Definition	Count	Interpretation
1	Sub-100 ppm	25	Quantitatively precise
2	100–10,000 ppm	∼55	Quantitatively meaningful
3	Qualitative/structural	∼140	Yes/no or structural

2 Tier 1: Sub-100 ppm Predictions

#	ID	Prediction	ppm	Scope	Experiment
1	V.T54	Electron mass (10-link chain)	0.025	τ-eff	CODATA
2	IV.T110	m_n/m_e ratio	0.025	τ-eff	CODATA
3	IV.T86	Rydberg constant (7 sig figs)	0.026	τ-eff	Spectroscopy
4	IV.T107	$\alpha^{-1} = 137.036$ (holonomy)	∼0	τ-eff	CODATA / Cs recoil
5	IV.D338	M_W NLO	−0.4	τ-eff	CDF-II / LHCb
6	IV.T177	M_W window universality	−0.5	τ-eff	LHCb / FCC-ee
7	IV.D337	$\sin^2\theta_W$ (NNLO)	−0.7	τ-eff	EW precision

#	ID	Prediction	ppm	Scope	Experiment
8	IV.T182	g_A axial coupling	+5.5	τ-eff	Neutron β decay
9	V.T189	Neutrino grid optimum	+7.4	τ-eff	DESI / JUNO
10	IV.T166	Higgs mass ($n = 7$)	+8.0	τ-eff	LHC Run 3
11	IV.T176	m_μ/m_e NNLO ($k = 15/2$)	−8.2	τ-eff	Muon precision
12	IV.T180	Muon $g - 2$	+8.8	τ-eff	FNAL $g - 2$
13	IV.T143	Koide $Q = 2/3$ (σ-symmetry)	−9	τ-eff	Lepton mass
14	V.D254	Silk damping ℓ_D	+9	conj	Planck legacy
15	V.T198	n_s spectral index $(1 - 2/57)$	+13	τ-eff	Planck/CMB-S4
16	IV.T185	Proton charge radius NLO	+12	conj	PRad-II / MUSE
17	IV.T194	Higgs self-coupling λ_H	+16	τ-eff	HL-LHC
18	IV.P184	NLO mass correction $(6/5)\iota_\tau^5$	10.5	τ-eff	CODATA
19	V.T07	NLO at 10.5 ppm	10.5	τ-eff	CODATA
20	IV.T142	p-n mass difference	+33	τ-eff	Lattice QCD
21	IV.D339	α_s at Z-pole (NLO)	+43	τ-eff	LEP/LHC
22	IV.T169	m_μ/m_e NNLO ($k = 23/3$)	+43	τ-eff	Muon precision
23	IV.T66	$\sin^2\theta_W$ complete EW table	86	τ-eff	EW precision
24	IV.T190	m_t/m_b ratio	+99	τ-eff	LHC top precision
25	V.P112	$Y_p = 20/81$	0.43σ	estab	BBN / CMB

All 25 predictions derive from ι_τ with zero free parameters. The *calibration anchor* (m_n) is used once to set the energy scale; every other mass, coupling, and cosmological parameter follows.

3 Tier 2: Quantitative Predictions (100–10,000 ppm)

#	ID	Prediction	ppm	Scope	Experiment
1	V.T52	$G = (c^3/\hbar)\iota_\tau^2$	3	τ-eff	CODATA
2	V.T264	ℓ_1 CMB first peak (coupled NLO)	+119	τ-eff	Planck
3	V.T259	$h = 2/3 + \iota_\tau^2/17$	−120	τ-eff	SH0ES/JWST
4	V.T262	ω_b NLO	+264	τ-eff	Planck
5	V.T265	Neutron lifetime	+340	τ-eff	Bottle experiments
6	IV.T191	m_u quark mass	+395	τ-eff	Lattice QCD
7	V.T234	$\Omega_\Lambda = \kappa_D(1 + \iota_\tau^3)$	−433	τ-eff	Planck/DESI
8	IV.T175	θ_{23} PMNS (NNLO)	−494	τ-eff	DUNE
9	V.T269	η_B NLO	−655	τ-eff	BBN precision
10	V.T261	Peak ratios ℓ_2, ℓ_3	−663/ + 1267	τ-eff	Planck
11	V.T199	ω_m DE-closure	−675	conj	DESI/Euclid
12	IV.T165	Wolfenstein $A = 1 - (3/2)\iota_\tau^2$	−887	τ-eff	LHCb
13	IV.T164	$\bar\rho = 1/(2\pi)$	+974	τ-eff	CKM
14	V.T267	BAO NNLO (5 bins)	∼1145	τ-eff	DESI
15	IV.T190	Top quark mass (standalone)	−1449	τ-eff	LHC
16	IV.T186	Proton g-factor	+2000	conj	Precision g
17	IV.T168	$\bar\eta$ CKM parameter	−2285	τ-eff	CKM triangle
18	IV.T152	Cabibbo angle $\lambda_C = \iota_\tau(1 - \iota_\tau)$	−2327	τ-eff	V_{us}
19	V.T241	D/H from τ-native η_B	+2800	τ-eff	BBN precision
20	IV.T174	θ_{12} PMNS	+3106	conj	JUNO/DUNE
21	IV.T49D	$\delta_{\rm CP}$ NLO	+5645	conj	DUNE
22	V.T166	$\Sigma m_\nu = 0.089$ eV	—	τ-eff	DESI/Euclid
23	V.R298	$m_3 \sim 50.7$ meV	—	τ-eff	KATRIN/Project 8

4 Tier 3: Structural and Qualitative Predictions

4.1 Particle Physics

ID	Prediction	Falsifying Observation
IV.T72	Proton absolutely stable ($\tau_p = \infty$)	Observed proton decay
IV.T160	$\theta_{\text{QCD}} = 0$ exactly	Nonzero θ_{QCD}
IV.T161	Neutron EDM = 0 exactly	$d_n > 0$ at any level
IV.P64	Exactly $N_\nu = 3$ families	4th generation discovery
IV.T146	All neutrinos Majorana	Definitive Dirac identification
IV.R395	Normal mass ordering	Inverted ordering confirmed
IV.P195	No axion needed	Axion discovery
IV.T83	Exactly 3 generations (topological)	4th generation
IV.T100	Ontic couplings do not run	Genuine ontic running

4.2 Black Hole Physics

ID	Prediction	Falsifying Observation
V.T110	BH horizon topology is T^2	Definitive S^2 observation
V.T168	QNM frequency ratio $= \iota_\tau^{-1} \approx 2.930$	QNM spectroscopy disagreement
V.T184	BH shadow +2.91% over Schwarzschild	EHT precision shadow
V.T96	EVPA winding number $w = 2$	Polarimetric $w = 1$
V.T114	No BH evaporation	Observed BH mass decrease

4.3 Cosmology

ID	Prediction	Falsifying Observation
V.P136	$r = \iota_\tau^4 = 0.01357$	CMB-S4 / LiteBIRD
V.T106	$\Omega_k = 0$ exactly	Nonzero spatial curvature
V.C17	No inflaton field	Inflaton particle discovery
V.P113	$N_{\text{eff}} \leq 3$	$N_{\text{eff}} > 3$ confirmed
V.T119	Eternal circulation	Definitive heat death evidence
V.R282	$\Lambda = 0$ exactly	True vacuum energy detected
V.T235	No phantom crossing: $w(z) > -1$ always	$w(z) < -1$ confirmed
V.T48A	21cm signal $T_{21}(z{=}17) \approx -209\,\text{mK}$	EDGES/SARAS3 inconsistent

4.4 Dark Sector

ID	Prediction	Falsifying Observation
V.T100	No fifth sector	DM particle detection
V.T102	No DM, no DE, no 5th force	Any dark particle/force/field
V.T85	Rotation curves from capacity	Systematic failure of zero-param curves
V.R302	No fifth force	Fifth-force detection

5 Experiment × Prediction Alignment

Experiment	Timeline	Tier 1 Tests	Tier 2 Tests	Tier 3 Tests
CODATA/PDG	Ongoing	6	1	—
LHC/HL-LHC	2025–2035	10	5	3
FNAL $g-2$	2025–2026	1	—	1
DESI/Euclid	2024–2030	—	5	3
CMB-S4	2029–2033	2	4	3
JUNO	2026–2030	1	1	2
DUNE	2028–2035	—	3	2
PRad-II/MUSE	2026–2028	1	—	—
KATRIN/Proj. 8	2025–2030	—	1	1
nEDM@PSI	2025–2030	—	—	1
EHT/ngEHT	2027–2035	—	—	3
LIGO O5/LISA	2025–2040	—	—	3
LZ/XENONnT	2025–2028	—	—	1
EIC	2032+	—	—	1

6 Timeline

6.1 Now (2025–2026)

Nine Tier 1 predictions are already confirmed to available experimental precision: m_e, m_n/m_e, Rydberg, α^{-1}, M_W, $\sin^2\theta_W$, g_A, m_H, and $g-2$. The primordial helium fraction $Y_p = 20/81$ matches observations at 0.43σ.

6.2 Near-Term (2026–2030)

- **CMB-S4:** $r = \iota_\tau^4$ at 14σ significance (decisive test)
- **DESI:** $\Sigma m_\nu = 0.089\,\text{eV}$ at 4.5σ
- **JUNO/DUNE:** Normal mass ordering at $3\sigma+$
- **LZ/XENONnT:** No DM particles (decisive for dark sector closure)
- **PRad-II:** Proton radius at $+12\,\text{ppm}$ precision

6.3 Medium-Term (2030–2040)

- **HL-LHC:** Higgs self-coupling λ_H at ∼50%; FCC-hh definitive
- **ngEHT:** BH shadow and QNM spectroscopy
- **Belle II/LHCb:** Full CKM matrix precision
- **HERA/SKA:** 21cm global signal

6.4 Long-Term (2040+)

- **LISA:** GW echoes testing T^2 BH topology
- **Hyper-K:** Proton lifetime pushing

7 The Existential Test: $r = \iota_\tau^4$

The tensor-to-scalar ratio r is derived from the holonomy of the τ^3 fibration:

$$r = \iota_\tau^4 = \left(\frac{2}{\pi + e}\right)^4 = 0.01357$$

CMB-S4 (expected first data ∼2029) will measure r with sensitivity $\sigma(r) \approx 0.001$. If $r = 0.01357$:

- Detection at $\mathbf{14\sigma}$ — unambiguous confirmation.
- First parameter-free prediction of B-mode polarization amplitude.

If $r < 0.005$ or $r > 0.025$:

- Irreconcilable tension with the framework.
- This is the single highest-stakes prediction in Category τ.

No wiggle room. The prediction is exact, falsifiable, and approaching experimental reach.

8 Five Decisive Tests

#	Test	τ-Prediction	Timeline	Falsification Criterion
1	$r = \iota_\tau^4$	0.01357	CMB-S4, ∼2029	$r < 0.005$ or $r > 0.025$
2	Σm_ν	0.089 eV	DESI, ∼2028	< 0.06 or > 0.12 eV
3	No DM	Zero particles	LZ, ∼2026	Any DM detection
4	Normal ordering	$r < p \Rightarrow$ normal	JUNO, ∼2028	Inverted at $> 3\sigma$
5	λ_H	0.12928	HL-LHC, ∼2032	κ_λ inconsistent with SM

9 Honest Limitations

1. **Single calibration anchor:** The neutron mass m_n is an experimental input. The framework cannot predict its absolute value from first principles — it sets the energy scale.

2. **Condensed matter gap:** Coverage of condensed matter physics (~ 25 entries) is the clearest structural deficiency. No BCS superconductivity, no topological phases, no band structure derived.

3. **Pareto barrier in CMB:** Simultaneous optimization of all CMB observables hits a coupled-constraint barrier. Peak ratios are sub-1300 ppm but not yet sub-100 ppm.

4. **Conjectural entries:** 232 of 4,547 registry entries (5.1%) remain conjectural. These include PMNS angle θ_{12}, δ_{CP}, and the proton g-factor.

5. **Cluster problem:** In astrophysics, galaxy cluster mass discrepancies ($D_\tau \sim 2$–4 vs. $D_{\mathrm{obs}} \sim 5$–7) are not fully resolved.

6. **Lean formalization:** 2,675 of 4,547 entries are Lean-formalized. The remaining 1,872 include 826 not-applicable (remarks, examples) and 1,046 awaiting formalization.

7. **No peer review yet:** The series has not undergone formal peer review. This pack is provided to enable exactly that process.

Compiled from 4,547 registry entries across 7 books. All predictions from $\iota_\tau = 2/(\pi + e)$ with zero free parameters. Registry data available at `https://panta-rhei-books.org/downloads`.