

UNIFIED VACUUM GEOMETRY

Unified Vacuum Geometry 2.0

A Geometric Theory of Physical Reality

Michael Marsden · Chico, California · 2026

"The vacuum is not empty — it is the ground of all being."

Physics at a Crossroads

Three unresolved crises demand a foundational reconception



1 QM vs. General Relativity — Fundamental Incompatibility

Quantum mechanics requires a fixed background spacetime; general relativity treats spacetime itself as the dynamical field. After a century of effort, no consistent quantum theory of gravity exists.



2 19 Free Parameters — The Standard Model's Silent Confession

The Standard Model cannot derive the masses, charges, and mixing angles of elementary particles from first principles. These numbers are inserted by hand, measured from experiment, never explained.



3 The Hubble Tension — A Universe Measuring Itself Inconsistently

CMB-based measurements give $H_0 \approx 67$ km/s/Mpc; local distance-ladder measurements give $H_0 \approx 73$ km/s/Mpc. A 5σ discrepancy with no accepted explanation within Λ CDM or its extensions.

“

*Physical reality is not a collection of fields inhabiting an inert spacetime.
It is entirely geometric. Every region of what we casually call vacuum is richly
structured geometry, and it is from the behaviour, deformation, and self-consistency
of this geometry that all known physics emerges as a natural consequence.*

”

— MICHAEL MARSDEN • AUTHOR'S PREFACE, UVG 2.0

ONE VACUUM

ONE GEOMETRY

ONE THEORY

The UVG Vacuum Manifold



LORENTZIAN METRIC

 $g_{\mu\nu}$ Sig. $(-, +, +, +)$

Encodes the causal structure of spacetime. Non-zero everywhere — there is no truly empty region of M_{vac} .

GRAVITY SECTOR



TORSION TENSOR

 $T_{\lambda\mu\nu}$ Antisymmetric $\leftrightarrow$ lower indices

Generates the weak force gradient. Responsible for matter-antimatter asymmetry via torsion-driven CP violation.

WEAK FORCE · SU(2)



NON-METRICITY TENSOR

 $Q_{\lambda\mu\nu}$ $Q_{\lambda\mu\nu} = -\nabla_{\lambda}g_{\mu\nu}$

Generates the strong force gradient. Color confinement emerges as a non-metricity closure condition.

STRONG FORCE · SU(3)



COUNTERSPACE DUAL

 M^*_{vac} Projective inversion · $\partial/\partial x^*$

Holographic boundary encoding all mass and charge. Generates electromagnetism via counterspace coupling $\partial/\partial x^*$.

ELECTROMAGNETISM · U(1)



All three sectors are non-zero, coupled, and simultaneous. The UVG action couples $g_{\mu\nu}$, $T_{\lambda\mu\nu}$, and $Q_{\lambda\mu\nu}$ in a single variational principle.

Matter as Topological Defect

PILLAR II · PARTICLES ARE GEOMETRY, NOT POINT MASSES

Baryons — Torus Topology



 $\chi = 0$ · Torus

- Proton: triadic mode $\{4, 4, 1\}$ · digital root = 9
- Neutron: triadic mode $\{1, 4, 4\}$ · digital root = 9
- Mass = holographic projection from M^*vac boundary

$$\boxed{4} + \boxed{4} + \boxed{1} = dr \ 9$$

Torus topology prevents isolation — confinement is geometric, not dynamic

vs

Leptons — Spherical Mode



 $\chi = 2$ · Sphere

- Electron: $l = 1$ F#3 180 Hz
- Muon: $l = 3$ C#5 540 Hz
- Tau: $l = 5$ Bb6 1800 Hz
- Three generations — spectrum exhausted. No fourth generation exists.

$$\boxed{1} + \boxed{3} + \boxed{5} = dr \ 9$$

Harmonic mode spectrum $\{1, 3, 5\}$ is fully exhausted — a topological, not empirical, limit

Four Forces — One Geometry

PILLAR III — FORCES AS GEOMETRIC GRADIENTS OF M_{vac}



GRAVITY
Metric Sector

$R_{\mu\nu\lambda\rho}$

Metric sector of M_{vac} . General relativity emerges as the low-energy limit of the UVG metric field equation.

$g_{\mu\nu}$ field



ELECTROMAGNETISM
Counterspace Sector

$\partial/\partial x^*$

Coupling between M_{vac} and its projective dual M^*_{vac} . $U(1)$ gauge symmetry from counterspace topology.

$U(1)$ gauge



WEAK FORCE
Torsion Sector

$\nabla_\lambda T_{\lambda\mu\nu}$

Gradients of the torsion tensor. $SU(2)$ gauge group from torsion geometry. W and Z masses derived, not fitted.

$SU(2)$ gauge



STRONG FORCE
Non-Metricity Sector

$\nabla_\lambda Q_{\lambda\mu\nu}$

Gradients of the non-metricity tensor. $SU(3)$ gauge group. Color confinement = non-metricity closure condition.

$SU(3)$ gauge

⚠ Standard Model gauge group $SU(3)\times SU(2)\times U(1)$ derived from UVG geometry — not postulated.

Counterspace Duality & Holographic Mass



The Dual Manifold M^*_{vac}

For every geometric structure S in M_{vac} there exists a dual S^* in M^*_{vac} , related by projective inversion through the null cone of M_{vac} . Physical observables arise from the geometric mean of S and S^* .



Holographic Mass

Mass is not an intrinsic property of matter. It is a holographic projection from the counterspace boundary — an information-geometric quantity encoded at M^*_{vac} . This resolves the hierarchy problem without supersymmetry or extra dimensions.



Proton Mass from Geometry

The proton mass (**938.3 MeV**) is derived from the information-geometric content of the torus-topology defect boundary in M^*_{vac} — not fitted to data. Mode {4,4,1}, digital root = 9.



Prediction 6 · Ch. 20

$\alpha_{UVG} \approx 1/137.036$ — derived from the Clifford algebra $Cl(1,3)$ geometry of the counterspace boundary M^*_{vac} . A first-principles derivation, not an experimental input.



Morphic Fields as Geometric Attractors



The Morphogenetic Problem

DNA alone cannot account for the three-dimensional structure of organisms. UVG 2.0 identifies morphic fields as **stable attractor basins** in the vacuum geometric phase space of M_{vac} — the ground of biological form.



The Morphic Field Equation

The UVG morphic field equation determines a coherence length:

$$L_m = 7.6 \pm 0.3 \mu m \text{ at } 37^\circ C$$

Corresponds precisely to the EZ water infrared absorption wavelength and cellular-scale biological organisation.



Embryogenesis as Phase Transition

Embryonic development is a **topological phase transition** in the vacuum manifold M_{vac} . DNA is the molecular scaffold interacting with the geometric attractor basin — not the sole determinant of form.



Experimental Prediction 7

Morphic coherence length $L_m = 7.6 \pm 0.3 \mu m$ at $37^\circ C$

Measurable *now* with optical and infrared microscopy of biological systems and EZ water layer experiments. No new instrumentation required.

The Universe Sings in F# Major

Interior angles of regular polygons → harmonic frequencies → the chord of geometric space

 TRIANGLE · 180°

f₀

180 Hz = F#3

Triangle (180°) → **Vacuum fundamental f₀**. The ground mode of M_{VAC}. Every harmonic is a multiple of this seed.

 SQUARE · 360°

Oct. 2

360 Hz = F#4

Square (360°) → **Octave 2**. F# Major root. 2 × f₀. Full rotation of geometric space encoded in sound.

 PENTAGON · 540°

Maj 3rd

540 Hz = C#5

Pentagon (540°) → **Major third of F#**. 3 × f₀. The harmonic fifth relationship of F# Major emerges from five-fold symmetry.

 HEXAGON · 720°

Oct. 3 ★

720 Hz = F#5

Hexagon (720°) & **ALL convex polyhedra** via Descartes' theorem. 4 × f₀. Octave 3 — the convergence point of geometry.

 DESCARTES' THEOREM

Δ = 720°

720° Universally

Every closed convex polyhedron carries total angular defect **Δ = 720°**. Every 3D geometric form resonates at F#5 — without exception.

 SELF-CONSISTENCY

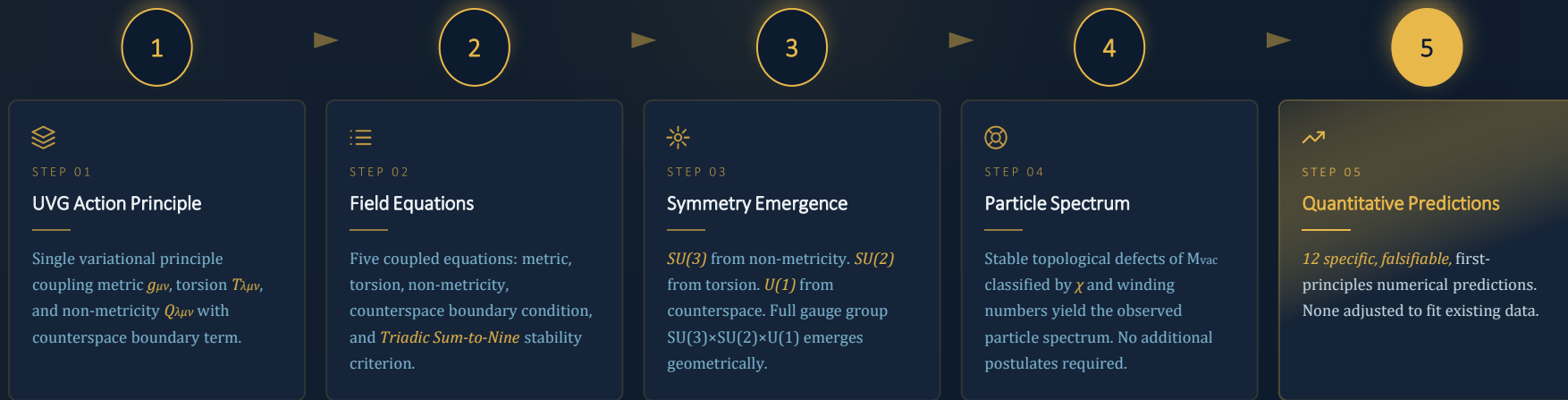
F# Major Chord

F# - C# - F#

F# – C# – F#: the **self-consistency condition** of geometric space. *Derived, not imposed.*

From Vacuum Geometry to the Standard Model

The logical chain from M_{vac} to observed physics



One action principle → five field equations → three gauge symmetries → full particle spectrum → **12 falsifiable predictions** — derived, not postulated.

Resolving the Hubble Tension

PREDICTION 1

$H_{0\text{UVG}} = 71.2 \pm 1.5 \text{ km/s/Mpc}$ · NATURAL INTERMEDIATE VALUE FROM VACUUM GEOMETRIC TENSION

UVG

The Problem

PLANCK 2018 (CMB) $H_0 \approx 67.4 \text{ km/s/Mpc}$

SHOES / HST $H_0 \approx 73.0 \text{ km/s/Mpc}$

⚠️ 5.0σ

Statistically decisive discrepancy.
No accepted explanation within Λ CDM or its extensions.

Planck (early)

Gap = 5.6 km/s/Mpc

SHOES (local)

67.4

← tension →

73.0

The UVG Resolution

Dark energy in UVG is **vacuum geometric tension** — not a cosmological constant. The effective tension relaxes slightly from early to late universe via the **non-metricity geometric field**, producing a natural intermediate H_0 :

UVG PREDICTION $H_{0\text{UVG}} = 71.2 \pm 1.5 \text{ km/s/Mpc}$

67.4 (Planck)

71.2 (UVG)

73.0 (SHOES)

✔️ $1.1\sigma / 1.2\sigma$

Consistent with Planck at 1.1σ .
Consistent with SHOES at 1.2σ .
Both measurements simultaneously satisfied.



Testable now — DESI Year 3 · Euclid DR1 · Rubin Observatory LSST

ALSO PREDICTED:

$w_0 = -1.002 \pm 0.003$ Dark energy EOS

PRED3

$w_a = +0.008 \pm 0.002$ EOS running

PRED4



Chapter 20, UVG 2.0 — Marsden 2026

Dark Matter & Dark Energy from Geometry

UVG eliminates the need for new particle species



PILLAR IV — DARK MATTER

Dark Matter = Counterspace Condensates

Dark matter is **not a new particle**. It consists of counterspace condensate states in M^*_{vac} — the dual-manifold complement of ordinary vacuum geometric excitations. Predicted density profile matches galaxy rotation curve observations.



APPENDIX G — RUSSELL ELEMENTS

Russell Elements as Dark Matter

Walter Russell's pre-hydrogen periodic elements correspond precisely to UVG **counterspace condensate states** — the dominant constituent of dark matter.

Prediction 5 · $S_0UVG = 0.789 \pm 0.007$ (CMB lensing)



PILLAR IV — DARK ENERGY

Dark Energy = Vacuum Geometric Tension

Dark energy is the **geometric tension** of the vacuum manifold M_{vac} — an intrinsic property of the ground state, not a separate field.

Prediction 8 · $l_{eff} = 85 \pm 5 \mu m$ (Effective tension cutoff)



COSMOLOGICAL CONSTANT PROBLEM

Cosmological Constant Resolved

The **120-orders-of-magnitude** cosmological constant problem is dissolved — vacuum energy in UVG is not additive across scales but is determined by the **holographic boundary condition** of M^*_{vac} .



Key consequence: No dark matter particle detector will yield a direct detection signal — because dark matter is a geometric condensate state of M^*_{vac} , not a massive particle species. Null results at LUX-ZEPLIN and XENONnT are **predicted outcomes**, not failures.

The Twelve Falsifiable Predictions

All derived from first principles · None fitted to data

H₀UVG P1 71.2 ± 1.5 <i>km/s/Mpc</i> ✓ DESI · Euclid · Rubin	TENSOR-SCALAR R P2 0.003 <i>Starobinsky-UVG</i> ✓ CMB-S4 · LiteBIRD	W₀ P3 -1.002 ± 0.003 <i>Dark energy EOS</i> ✓ DESI BAO + SNe Ia	W_a P4 $+0.008 \pm 0.002$ <i>EOS running</i> ✓ DESI BAO + SNe Ia	S₈UVG P5 0.789 ± 0.007 <i>CMB lensing</i> ✓ KiDS-1000 · DES Y6	AUVG P6 $1/137.036$ <i>From C(1,3)</i> ✓ CODATA 2026
LM P7 $7.6 \pm 0.3 \mu\text{m}$ <i>At 37°C</i> ✓ EZ water · IR microscopy	LEFF P8 $85 \pm 5 \mu\text{m}$ <i>Vacuum cutoff</i> ✓ Casimir · tabletop	M_Σ P9 $\approx 214 \text{ MeV}$ <i>Morphic mass</i> ✓ Neutrino cosmology	LEPTON GEN. P10 Max 3 <i>{1,3,5} exhausted</i> ✓ LEP · FCC-ee	SUPERCOND. P11 Room-temp <i>Torsion Cooper</i> ✓ Materials lab	FAU P12 1260 Hz <i>Hg→Au MNTR</i> ✓ Appendix I design

The Triadic Sum-to-Nine Theorem

Appendix H — A geometric stability criterion for all physical states



Σ Theorem H.1
Formal Statement

stable if and only if

9

This is both *necessary* and *sufficient*.
 $Digital\ root(n_1 + n_2 + \dots) = 9 \Leftrightarrow$
Geometric stability

 Particle
Classification

Proton	$\{4,4,1\} \rightarrow 4+4+1$	= 9 ✓
Neutron	$\{1,4,4\} \rightarrow 1+4+4$	= 9 ✓
Leptons	$\{1,3,5\} \rightarrow 1+3+5$	= 9 ✓

Three lepton generations only — spectrum exhausted at $l = 1, 3, 5$. No fourth generation exists.

 Color
Confinement

special case

$\neq 9$

 Confinement is not dynamic

— it is **topological**

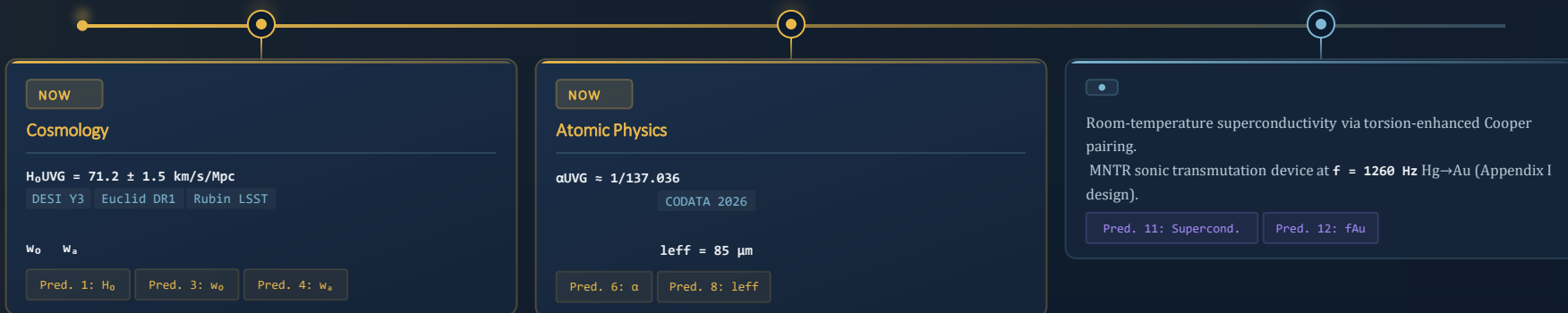
 The Tesla Axis
{3, 6, 9}



A **special sub-spectrum** of Theorem H.1, corresponding to pure **torsion modes** of M_{vac} — the geometric foundation of the resonance structures Tesla identified experimentally ...*without a formal framework*.

Experimental Programme — Testing UVG 2.0

All 12 predictions testable with current or near-future instrumentation



Public Domain Release

UVG 2.0 is freely available to the global research community



Complete Manuscript — Public Domain

21 chapters · 9 appendices · 15 documents · 80+ references.

Released *without restriction*. No license, no fee, no embargo.

Free for academic research, education, software implementation, and derivative theoretical work.



For Computational Physicists

Implement numerical simulations of the UVG field equations.

Full mathematical derivations of $g_{\mu\nu}$, $T_{\lambda\mu\nu}$, and $Q_{\lambda\mu\nu}$ field equations in Appendix C.
Clifford algebra $Cl(1,3)$ reference framework in Appendix A.



For Educators

Geometric unification approaches suitable for graduate-level courses in differential geometry, particle physics, and cosmology.

Counterspace duality as a teaching framework for holographic mass.



For Experimentalists

Chapter 20 is a standing experimental invitation.

Twelve predictions — all quantified, all testable, all falsifiable.

Confirm or refute: both outcomes advance the science.



An Invitation to the Scientific Community

UNIFIED VACUUM GEOMETRY 2.0 · MICHAEL MARSDEN · 2026

UVG 2.0 is an opening framework — the most coherent and mathematically consistent geometric theory of the vacuum yet articulated. The twelve predictions of Chapter 20 are a standing invitation: confirm them or refute them. That is the nature of science, and this work embraces it without reservation.

①

Test a Prediction Chapter 20
details all instrumentation
requirements.

②

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