One Geometry, Four Forces

How gravity, electromagnetism, the weak force, and the strong force emerge as four low-energy projections of one 13-dimensional geometry

The capstone to five consistency notes — with an honest scoreboard of how far each one closes

A mostly non-technical note for anyone who loves quantum physics

written to be checked by specialists, and read, equations and all, by everyone else

[Author] · physics.magflowmeters.com

Before we start

The four earlier notes in this series each checked one force on its own — gravity bending starlight, electromagnetism binding hydrogen, the weak force timing the muon's decay, the strong force holding quarks at short range. This last note asks the question they were building toward: are these four really four unrelated things, or four low-energy faces of one geometric object?

The answer the thirteen-dimensional construction proposes is precise, and it needs stating carefully so it is neither undersold nor oversold. The forces are **not** the same in the laboratory — they have different charges, different carriers, different ranges, different strengths, and nobody is claiming otherwise. The claim is that their *origin* is common: one higher-dimensional geometry reduces to a single four-dimensional theory — a metric, a set of gauge fields, and matter coupled through one covariant derivative — and the four forces are different pieces of that one structure. We check this the same way as before: for each force, take the simplest exchange process, compute the standard result, and show the same result following from the one reduction. And because this note ties four checks together, it ends with an honest scoreboard — because a synthesis is exactly where a reader might mistake 'one origin' for 'everything solved,' and the four checks do not all close to the same degree. You can read every word skipping every equation.

1. The one template behind the four

Begin with the single picture every one of the four checks turned out to share. A force, in quantum terms, is an exchange: one source emits a field quantum, the quantum propagates, a second source absorbs it, and the amplitude of that exchange becomes a force, a potential, or a decay rate. Schematically,

$$M\_i(q) \approx J_1 \cdot P\_i(q) \cdot J_2,$$

a source current J at each end and the mediator's propagator P in between. Everything that makes the four forces look different is contained in three slots: which source/current sits at the ends, which mediator carries the middle, and whether that mediator is massless (long-range) or massive (short-range), Abelian or non-Abelian.

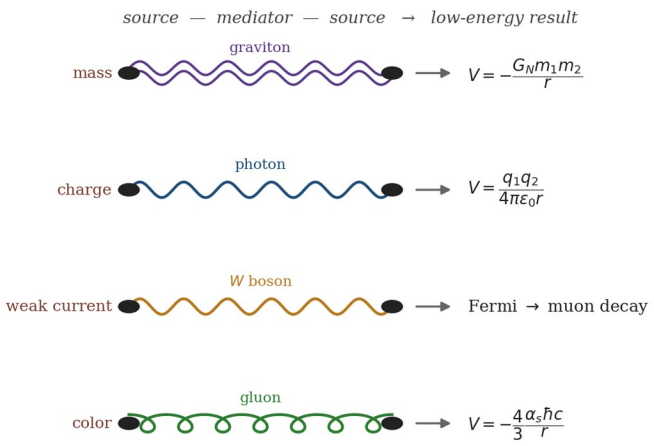

Figure 1. *One exchange template, four forces. Each force is a source coupled through a mediator to a second source; the mediators are drawn in their conventional styles (graviton double-wavy, photon and W single-wavy, gluon coil). The same architecture yields a different low-energy result in each case.*

Filled in, the four cases are: gravity, with mass-energy as the source and the massless spin-2 graviton as mediator (long-range, universally attractive); electromagnetism, with electric charge and the massless photon (long-range, attractive or repulsive); the weak force, with the weak current and the massive W and Z (so short-range — a contact interaction at low energy); and the strong force, with color charge and the gluons (Coulomb-like at short distance, confining at long). Same template, four fillings.

2. The standard route: four forces, one exchange pattern

In the standard route — ordinary physics, no geometry — the four simplest examples are exactly the four earlier notes, and it is worth seeing them lined up. One-graviton exchange between two masses gives Newton's potential V = −G_N m₁m₂/r. One-photon exchange between two charges gives Coulomb's V = q₁q₂/4πε₀r, and hence the hydrogen spectrum. W exchange in muon decay, with the W too heavy to propagate far, collapses to the Fermi contact interaction and gives the muon lifetime Γ_μ = G_F² m_μ⁵/192π³. And one-gluon exchange between a heavy quark and antiquark gives the short-distance color-Coulomb potential V = −(4/3)α_s ħc/r. Four processes, one exchange architecture — each derived in full in its companion note.

3. The 13D route: one geometry, one connection

Now the same four, from one geometry. The thirteen-dimensional construction begins from a single object — four-dimensional spacetime times a small internal shape:

$$M_{13} = M_4 \times K_6 \times S^2 \times S^1\_Y, \quad K_6 = SU(3)/T^2.$$

Its reduction to four dimensions is meant to land on one effective action containing the metric, the gauge fields, and matter — and the unifying object, the thing that makes ‘one force’ precise, is a single covariant derivative acting on matter:

$$D_\mu = \nabla_\mu^{\text{spin}} + ig_s G_\mu^a T_c^a + ig\, W_\mu^i T_L^i + ig' B_\mu Y$$

Read it by its colors: the spin-connection term (purple) is gravity — the geometry of spacetime itself; the SU(3)_c term (green) is the strong force; the SU(2)_L term (amber) is the weak force; and the hypercharge U(1)_Y term (blue) combines, after electroweak symmetry breaking, with the third weak component to give electromagnetism. One derivative, four interactions.

Where does each piece come from? The four factors of the geometry supply them: the spacetime factor M_4 gives the metric and its spin connection (gravity); the color shape $K_6 = SU(3)/T^2$ gives the strong SU(3)_c; the sphere S^2 gives the weak SU(2)_L; and the hypercharge circle S^1_Y gives U(1)_Y.

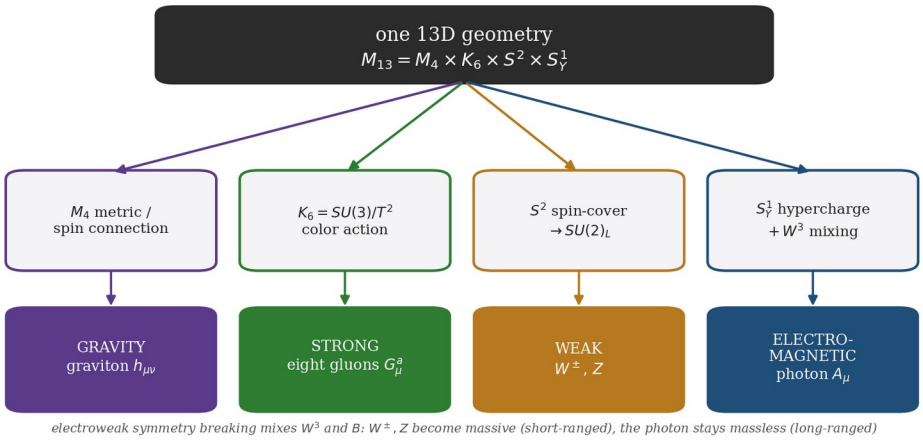

Figure 2. *One geometry, four projections. Each factor of the 13-dimensional geometry supplies one piece of the 4D theory; the four laboratory forces are different low-energy projections of the one structure. Electroweak symmetry breaking gives the W and Z mass (short range) while leaving the photon and graviton massless (long range).*

Each of the four earlier notes is then one reading of this single reduction. The gravity note quantized the metric piece; the hydrogen note used the unbroken electromagnetic piece; the muon note used the weak charged-current piece; the strong-force note used the color piece. The same C_F = 4/3, the same Coulomb 1/r, the same Fermi G_F, the same Newtonian potential — each falls out of its own slice of the one action. They are not four separate miracles; they are four corollaries.

4. The two routes meet

Side by side, the four checks share one architecture:

Interaction	Standard route	13D route	Simplest result
Gravity	Einstein–Hilbert → graviton	13D metric zero mode → EH action	$V = -G\, m_1 m_2 / r$
Electromagnetic	QED → photon	electroweak reduction → photon	$V = q_1 q_2 / 4\pi\varepsilon_0 r$
Weak	electroweak theory → W	$S^2 + S^1\_Y \to SU(2)\_L \to W$	$\Gamma\_\mu = G\_F^2 m\_\mu^5 / 192\pi^3$
Strong	QCD → gluon	$K_6 \to SU(3)\_c \to$ gluon	$V = -(4/3)\alpha\_s \hbar c / r$

The source changes, the mediator changes, the propagator changes — but the structural form is identical: a source coupled to a connection field that the one geometry selects. That shared structure, not any numerical coincidence between the forces, is what ‘one geometry, four forces’ means.

5. What “one force” means — and what it does not

This is the section to read slowly, because it is the easiest place in the whole series to overclaim. ‘One force’ here has a precise and limited meaning, and a tempting wrong one.

What it does mean: all four interactions arise from one higher-dimensional geometric origin and one covariant-derivative structure. The differences between them are downstream — they come from the geometry decomposing into different connection components, each coupling to its own current, and from electroweak symmetry breaking giving the W and Z mass while leaving the photon and graviton massless. That is why one geometric source can look like four very different forces in the laboratory: the weak force is short-ranged because its carriers are heavy; electromagnetism is long-ranged because the photon is massless; the strong force confines at long range though it is Coulomb-like up close; gravity is long-ranged and universal.

What it does not mean: that the four forces are numerically identical at laboratory energy (they are not), or that every coupling, mass, mixing, and quantum correction has been derived from the geometry with no measured inputs. That stronger statement would require the corpus to prove far more than these consistency checks establish. The honest version is the architecture claim: one origin, one connection structure, four projections — sharp enough to be falsified (a wrong charge assignment, a missing anomaly cancellation, a fifth force, or an extra light boson would each break it), but not a claim that everything is solved.

There is, though, one genuinely strong quantitative claim worth stating plainly, because it is the real over-determination: in this routing the five textbook force strengths carry **no new adjustable dials** of their own — each is either read off the

one frozen geometry or computed from the others — and two of them, the electric charge and the weak Fermi constant, are not independent inputs at all but identities fixed by the rest. An identity that disagreed with experiment would prove the geometry wrong. That is what makes ‘one geometry’ a claim you can break rather than a slogan you must accept.

6. The honest scoreboard

Because this note gathers four checks under one roof, here is the part that keeps the roof from looking sturdier than it is. The four forces do not close to the same degree — and pretending they did would be the exact dishonesty this series is built to avoid. Carried over from the individual notes:

Note (force)	Origin in the geometry	Simplest result recovered	Honest grade
Gravity — The Sun as a Lens	M_4 metric / spin connection	light bending, $\gamma = 1$ (Newton)	**closed by calculation***
Electromagnetism — Hydrogen	unbroken U(1)_em	Coulomb, -13.6 eV/n^2	**half-closed**
Weak — Muon Decay	$S^2 + S^1\_Y \to SU(2)\_L$	Fermi, muon lifetime	**well-supported**
Strong — Color-Coulomb	$K_6 = SU(3)/T^2 \to SU(3)\_c$	short-distance color force	**perturbative tip only**
Quantum gravity — Single Graviton	M_4 metric (quantized)	one-graviton → Newton	**low-energy EFT only**

(* conditional on the frozen-volume modulus.) Read the grades, not just the architecture. Two of the five — gravity’s classical light-bending and the weak force — are on firm ground; the others are partial in named, specific ways: the full QED reduction is still owed at the source, the strong check reaches only the perturbative tip with confinement walled off, and the quantum-gravity check is valid only at low energy with the Planck scale explicitly excluded by the corpus. The unification architecture is real; the individual closures are uneven, and honestly so.

7. What this does, and does not, show

What it shows: the four force notes are not isolated. They are four projections of one reduction, one action, one covariant derivative. If the corpus supplies that full four-dimensional action — the Einstein–Hilbert term, the three gauge sectors, the correct matter representations and charge assignments, electroweak breaking, and canonical normalizations — then the standard low-energy forms of all four forces follow as corollaries.

What it does not show: it does not, by itself, prove the full construction; it does not establish that the couplings are parameter-free unless the corpus derives them; it does not solve nonperturbative QCD or complete Planck-scale quantum gravity; it does not compute every loop correction; and it does not make the forces identical in the lab. It is a unification-architecture check — the four simplest force examples sharing one reduction and one connection structure — accompanied by an honest accounting of how far each goes.

The real evidence for the construction lies where it always has: in the over-determination — one frozen geometry, asked to source four forces and reproduce many particle properties from a handful of measured inputs, with no per-force adjustable dials. This note shows the four forces share one origin; the earlier notes showed each origin lands on the right physics; and the honesty throughout is the point, not a hedge.

8. The seam: one action, four corollaries

The thread of the whole series, pulled tight: a single thirteen-dimensional geometry reduces to one four-dimensional action, and the four forces are its parts — gravity the metric and spin-connection part, the strong force the SU(3)_c part, the weak force the SU(2)_L charged-current part, electromagnetism the unbroken U(1)_em part after symmetry breaking. The full reduction is written as a source-level checklist in Appendix A; what the corpus carries is the interface-level claim that the four projections fit together as views of one object, with explicit falsifiers and the hard sectors honestly bounded out. The four earlier notes verified, one at a time, that each projection lands on the textbook physics. This note’s modest and exact contribution is to show they are projections of the same thing — and its scoreboard is there so that ‘the same thing’ is never read as ‘everything.’

Appendix A — The unified reduction, the one covariant derivative, and the closure checklist

This appendix collects the unified structure the body describes, and ends with the source-level obligation that, if discharged in the corpus, makes the four force notes corollaries of one action rather than four separate results.

A.1 The unified four-dimensional action

The reduction target is a single 4D action containing gravity, the three gauge sectors, matter, and the Higgs, plus effective-field-theory corrections, built on the one geometry:

$$M_{13} = M_4 \times K_6 \times S^2 \times S^1_Y, \qquad K_6 = SU(3)/T^2$$

$$S_{13} \to S_4 = \int d^4x \sqrt{-g} \left[\frac{R}{16\pi G_N} - \tfrac{1}{4} G^a_{\mu\nu} G^{a\mu\nu} - \tfrac{1}{4} W^i_{\mu\nu} W^{i\mu\nu} - \tfrac{1}{4} B_{\mu\nu} B^{\mu\nu} + \bar{\Psi}\, i\hbar c\, \gamma^\mu D_\mu \Psi + |D_\mu H|^2 - V(H) + \mathcal{L}_{\text{Yuk}} + \mathcal{L}_{\text{EFT}} \right]$$

A.2 The one covariant derivative, term by term

All four interactions enter through a single covariant derivative acting on matter — the spin connection for gravity, and the three internal gauge connections:

$$D_\mu = \nabla^{\text{spin}}_\mu + i g_s G^a_\mu T^a_c + i g\, W^i_\mu T^i_L + i g' B_\mu Y$$

- — **spin connection ∇ᵐᵒⁿ — gravity** (from the spacetime factor M₄; couples to stress-energy).
- — **g_s Gᵃ Tᵃ_c — strong force** (from K₆ = SU(3)/T²; eight gluons, color triplets).
- — **g Wⁱ Tⁱ_L — weak force** (from the S² spin-cover; SU(2)_L, left-handed doublets).
- — **g′ B Y — hypercharge** (from S¹_Y; combines with the third weak component to give electromagnetism).

A.3 Electroweak breaking: photon, W, Z, and the charge

Electroweak symmetry breaking mixes the third weak component and hypercharge into the massless photon and the massive Z, leaves the photon unbroken, and fixes the electric charge as Q = T₃ + Y:

$$SU(2)_L \times U(1)_Y \;\longrightarrow\; U(1)_{\text{em}}, \qquad A_\mu = \sin\theta_W W^3_\mu + \cos\theta_W B_\mu, \qquad Q = T_3 + Y$$

A.4 The four results, one line

The simplest examples of the four forces, each derived in full in its companion note, in a single line:

$$V_{\text{grav}} = -\frac{G_N m_1 m_2}{r}, \quad V_{\text{EM}} = \frac{q_1 q_2}{4\pi\varepsilon_0 r}, \quad \Gamma_\mu = \frac{G_F^2 m_\mu^5}{192\pi^3}, \quad V_{q\bar{q}} = -\frac{4}{3}\frac{\alpha_s \hbar c}{r}$$

A.5 The source-level closure checklist

The remaining obligation is to exhibit, inside the corpus, the full reduction from the 13D geometry to the 4D effective action with all of the following — stated as a checklist so that nothing is assumed silently:

- 4D Einstein–Hilbert gravity; SU(3)_c, SU(2)_L, and U(1)_Y gauge fields, all with canonically normalized kinetic terms.
- Correct matter representations and chirality (no mirror sector); the charge operator $Q = T_3 + Y$.
- Electroweak symmetry breaking with the correct photon / W / Z identification; quarks and leptons coupled through the one covariant derivative.
- Newton's constant and the gauge couplings either derived or explicitly registered as inputs; no extra light gauge bosons or exotic charged/colored states outside the ledger.
- Bounded EFT corrections; and nonperturbative QCD and Planck-scale quantum gravity separated honestly from the perturbative, low-energy checks — bounded, not used as support.

A.6 What rests where

- **What the corpus establishes.** The interface-level claim that the four forces are mutually compatible projections of one geometry, with shared matter and charge conventions, explicit low-energy targets, and explicit falsifiers — plus the 'zero new dials' economy (e and G_F derived as identities). Deliberately narrower than a theory of everything.
- **What this note adds.** The synthesis: the four earlier checks share one exchange template, one reduced action, and one covariant derivative, and are therefore corollaries of a single structure rather than four independent results.
- **What remains uneven (the scoreboard).** The four closures differ: gravity's bending and the weak force are firm; electromagnetism's QED reduction is owed at source; the strong check is perturbative-tip only; the quantum-gravity check is low-energy EFT only. None of this is hidden — it is the scoreboard of Section 6.
- **What is excluded by name.** Nonperturbative QCD, Planck-scale quantum-gravity UV completion, strong CP, cosmology, dark matter, dark energy, and baryogenesis — named in the corpus as excluded, not failed, and not used to support any claim here.

> **Closed result.** Given the corpus's reduction of the one 13-dimensional geometry to a single 4D effective action with gravity, the three gauge sectors,

> the correct matter content and charge convention Q = T_3 + Y, and electroweak symmetry breaking, the four forces enter through one covariant derivative, and the standard low-energy forms — Newton, Coulomb, Fermi/muon decay, and the color-Coulomb potential — follow as four projections of that one structure. This is a unification-*architecture* check, conditional on the full reduction of Appendix A.5 — not a proof that every coupling is parameter-free, nor a solution of nonperturbative QCD or Planck-scale quantum gravity, and the four projections close to honestly different degrees (Section 6).

Notes and sources

[1] The ‘four forces as four projections of one geometry’ thesis, the projection maps, the shared charge convention Q = T_3 + Y, and the ‘zero new dials’ economy (with e and G_F as derived identities) are the central content of the source corpus, Paper II (‘Forces’): physics.magflowmeters.com/articles/Forces.html. It is explicitly an interface/consistency paper, narrower than a theory of everything, with the hard sectors bounded out.

[2] Per-force grounding and honest grades are carried in the five companion notes (below); each states its own conditional assumptions and excluded sectors.

[3] The excluded sectors — full quantum gravity / Planck-scale UV completion, nonperturbative QCD, strong CP, cosmology, dark matter, dark energy, baryogenesis — are named in the corpus as excluded, not failed, with a binding rule forbidding any claim from leaning on them (Paper I, ‘GUT’, scope ledger).

[4] The unified four-dimensional action, the combined covariant derivative, electroweak symmetry breaking, and the one-exchange results are standard; see any quantum-field-theory or Standard-Model text, plus the gravitational effective-field-theory literature for the graviton sector.

[5] Companion notes: *The Sun as a Lens* (gravity), *Hydrogen as a Quantum Electrostatic Check* (electromagnetism), *Muon Decay as a Weak-Force Check* (weak force), *The Color-Coulomb Potential as a Strong-Force Check* (strong force), and *Single-Graviton Exchange as a Quantum-Gravity Check* (quantum gravity).