Unified Geometric Fork Model v3.71

A geometric-topological description of baryons

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Abstract

The Unified Geometric Fork Model (UGFM) describes baryons as standing-wave nodes on a higher-dimensional hypersphere. In version 3.71 every baryon is a triple-junction (*Y-node*) where three string-like flux tubes meet. A quark's flavour fixes the tension τ of its outgoing string; small oscillations of the three prongs are coupled through an isotropic spring constant κ. Diagonalising the corresponding 3×3 stiffness matrix yields quantum mode energies $\hbar\omega_k$ whose sum reproduces the baryon mass. Calibrating only to the proton leaves the model parameter-free and reproduces the known baryon spectrum to a few percent. Spin, charge and confinement emerge as topological properties of the Y-node on a $\simeq 1$ fm hypersphere embedded in up to six spatial dimensions.

1 Introduction

The Unified Geometric Fork Model (UGFM) describes baryons as standing-wave nodes in a higher-dimensional "hypersphere" of space. In UGFM v3.71, each baryon is modeled as a triple-junction (*Y-node*) where three string-like flux tubes (world-strings) meet. A quark's flavor (u, d, s, c, b) determines the tension τ of its outgoing string. Small oscillations of the three prongs are coupled by a stiffness matrix K (size 3×3) with diagonal entries τ_i and an isotropic spring-like coupling κ between prongs. Diagonalizing K

yields eigen-frequencies ω_k, whose quantum energies $\hbar\omega_k$ sum to give the baryon's rest energy (mass). The overall energy scale is fixed by matching the proton mass, leaving the model otherwise parameter-free. This "mass from oscillations" picture replaces the older UGFM v3.1 formula of hand-tuned string and core energies, embedding mass generation in a single geometric mechanism.

Lay note: Imagine a baryon as a little three-pronged fork in space, with each prong under tension. Each prong's vibration affects the others through the fork's handle. The combined vibrational energy of the fork-node is what we identify with the particle's mass.

2 Topological Charge and Spin

In UGFM v3.71, spin and charge are topological properties of the Y-node. A node can carry a twist charge θ in one of its prongs. This twist behaves like a trapped "spinor": twisting a Y-node by π (half-turn) or 2π locks in a topological charge akin to a spinor on a string. Crucially, this twist-charge cannot unwind in ordinary 3D (it would require cutting the string), but in 4D/5D it can pass through the extra dimension and only fully relax after two full rotations (a 720° cycle). In other words, a single 360° turn alone does not return the node to its original state, but two turns do – reproducing the hallmark "spin-$\frac{1}{2}$" behavior. In UGFM terms, transferring a half-twist (π) from one branch to another and repeating it yields a full 720° cycle (two 360° turns) across different branches.

Mathematically, each branch i has a twist angle $\theta_i \in [0, 2\pi)$ and a topological charge $s_i = \theta_i/\pi$ (a half-coverage number). When two branches collide, a 4D "Reidemeister move" can transfer the twist from one to the other:

$$\theta_i \to 0, \qquad \theta_j \to \theta_j + \theta_i \pmod{2\pi}.$$

The twist energy E_{spin} is minimal when $\theta = 0$ or 2π and maximal at π, capturing the idea that an untwisted node is low-energy. Thus, UGFM links spin-$\frac{1}{2}$ to the property that only after two half-transfers (two π-twists) does the node's state repeat.

Furthermore, a Y-node carries two types of topology: the twist (spin) and the branching configuration itself. This combination behaves like a spinor on a string: the twist is a "spinor-like" quantity bound on a hanging loop, and the branching arrangement governs how that twist can hop between prongs. In UGFM parlance, node + twist = spinor on the string. Hence, "electric charge" and color charge are reinterpreted as manifestations of branch-twist topology in higher dimensions.

Lay note: Just as you need two full revolutions (720°) to unwrap a Möbius strip, the UGFM node requires two turns to return to its start point – neatly explaining the spin-$\frac{1}{2}$ property topologically.

3 The 1 fm Resonator and Hyperspherical Modes

UGFM posits that the "space" hosting baryons is a compact hypersphere of radius $R \sim 1$ fm. This value is not chosen by hand: it is the smallest resonator for which the fundamental spherical-harmonic mode ($\ell = 1$) reproduces the proton mass. Modes with $\ell = 0$ are mass-less (photon-like), while $\ell = 1, 2, 3$ around $R \simeq 10^{-15}$ m map to the known stable baryons; higher ℓ or very different R give unobserved, unstable excitations. Confinement thus emerges geometrically: a baryon's standing wave fits only inside a 1 fm "cell".

Lay note. Think of each baryon as a tiny 1 fm balloon. Only certain drum-like vibration patterns fit inside. The lowest ones are the proton, neutron and their siblings; the perfectly uniform beat ($\ell = 0$) has no mass and manifests as a photon.

4 Mass from Coupled String Oscillations

The baryon mass formula in UGFM v3.71 follows from the eigenmodes of the Y-node. For three strings the stiffness matrix is

$$K_{ij} = \begin{cases} \tau_i + \kappa\,(N-1) & \text{if } i = j, \\ -\kappa & \text{if } i \neq j, \end{cases} \qquad N = 3.$$

Diagonalising K gives eigenvalues λ_k and mode frequencies $\omega_k = \sqrt{\lambda_k / m_{\text{osc}}}$. The calibrated rest-energy is then

$$M_{\text{node}} \;=\; \sum_{k=1}^{3} \hbar\omega_k, \qquad M_{\text{node}}(p) = M_p \text{ (proton match)}.$$

With the proton fixing the single energy scale, all other baryon masses become predictions: light (Σ, Ξ) and heavy (Λ_c, Ξ_b) spectra agree with experiment to within a few percent. Mass therefore arises purely from quantised oscillations of the coupled strings, replacing the earlier UGFM 3.1 mixture of string and "core" energies.

Lay note. Imagine three violin strings tied together at the bridge. Pluck one, and the bridge shakes, sharing sound with the others. Add up all those shared notes and you get the baryon's mass.

5 Standing Waves and Group Velocity: Origin of Mass

On the hypersphere every vibrational mode satisfies the relativistic dispersion relation

$$\omega^2 = c^2 k^2 + \omega_0^2,$$

where the "rest-frequency" ω_0 fixes the inertial mass $m = \hbar\omega_0/c^2$. The group velocity of a wave-packet is therefore

$$v_g = \frac{d\omega}{dk} = \frac{c^2 k}{\omega} = \frac{c\,k}{\sqrt{k^2 + (\omega_0/c)^2}} \;<\; c\,.$$

For a photon-like mode ($\omega_0 = 0$) one recovers $v_g = c$, but for any $\omega_0 > 0$ part of the energy is locked in the standing oscillation, so the travelling disturbance slows: that loss of kinetic share is what we experience as mass. In UGFM, the standing wave *is* the baryon, and its stored vibration determines the inertia of the adjoining strings.

Lay note. Imagine a skipping-rope wave: if someone is already shaking the centre hard, some energy stays in that local wobble and the pulse you send travels more slowly. That stored wobble is the analogue of mass.

6 Extension to Six Dimensions

Earlier UGFM versions lived on a 4- or 5-sphere; version 3.71 upgrades the geometry to six spatial dimensions. Generalising the Laplacian from S^4 to S^5 and S^6 adds new harmonic modes and, crucially, allows the twist-transfer and reconnection moves needed to model proton–antiproton annihilation and heavy-quark baryons. Despite the added room, the low-ℓ spectrum ($\ell = 0, 1, 2, 3$) on a radius $R \simeq 1$ fm still matches the observed baryon families, while higher modes remain unstable. Thus the extra dimensions act as a hidden arena where colour flux can twist, cross and annihilate without spoiling the successful 5-D mass predictions.

Lay note. Giving the Y-strings more dimensions is like letting violin strings move on a drumhead instead of a line: more ways to wiggle and new notes to play, yet the simplest notes sound the same. Six dimensions let UGFM capture those extra wiggles required for exotic processes while keeping ordinary baryons intact.

7 The Fork Metaphor and Modal Coupling

In UGFM the triple-junction *Y-node* is likened to the handle of a three-pronged fork: each prong represents a quark-string held under its own tension τ_i, yet all three share a common junction. When one prong vibrates the handle moves, inevitably shaking the other two—mathematically this is the non-zero off-diagonal coupling $-\kappa$ in the stiffness matrix K. Replacing an u-string by an s-string, for example, stiffens one prong and shifts the entire set of eigen-frequencies ω_k, so the baryon mass is a genuinely collective property of the fork-node, not a sum of separate string energies.

Lay note. Imagine three guitar strings tied together at the bridge: pluck one and you hear sympathetic vibrations in the others. The baryon "fork" behaves the same—its mass is the total sound of all three coupled strings.

8 Speculative Notes

- **Beta decay as twist fracture.** Neutron β^- decay $(n \to p + e^- + \bar{\nu}_e)$ can be pictured as a Y-node in which a d-string converts to a u-string while ejecting a half-twist (W^-). The escaping electron carries most of that twist energy; the antineutrino is the residual untwist, naturally tiny in mass.
- **Baryon–antibaryon annihilation**. A proton–antiproton pair corresponds to two oppositely twisted Y-nodes. In six dimensions the nodes can reconnect and collapse in a "double torsional jump," releasing their energy as photons.
- **Dark-sector hints**. Higher-order twist modes that propagate primarily in the extra dimensions couple only weakly to visible strings, offering a geometric candidate for dark-matter excitations.

Lay note. Emitting a neutrino is like untying a small loop in the string network; annihilation is two forks snapping together and vanishing in a flash of light. In UGFM these dramatic events are just topology changing shape.

GIT python source code: https://github.com/8cinq/UGFM/

UGFM v1-2 (outdated):
https://drive.google.com/file/d/1Qcziek8AxmDmixI_EGiB5CInA06sZWys/view?usp=sharing