Mascon Framework: Origin of Matter in Hyperhamiltonian Quantum Mechanics, Unified Geometric Origin of Particle Masses, Baryons, Dark Matter and Fine-Structure Constant

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Abstract

We present a fully geometric, parameter-free derivation of the origin of all matter — ordinary baryons, dark-matter halos, and the particle mass spectrum — within hyperhamiltonian quantum mechanics (HHQM). In this approach we utilize the correspondence between three consistent paradigms R, C, H, of the observer and the three particle generations. A single object, the **mascon**, emerges as a localized defect of measure equivalence between the Haar (structural) and Lebesgue (metric) measures on the quaternionic monocosm H°. At the universal crossover scale $r^* = e^{-1}$, the same visibility kernel $K(x) = \Sigma(x) \cdot \Pi_{\text{time}}(\Sigma(x) = x/(1+x)^2, \Pi_{\text{time}} = 1/2)$ that already produces the observed baryon-to-dark-matter ratio $\Omega_{\text{DM}}/\Omega_b \approx 5.4$ and the fine-structure constant $\alpha^{-1} \approx 137.036$ in the cosmological setting now weights the microscopic Haar excess. The resulting mass spectrum is purely geometric: $m_{n,j,P} = n(2j+1)V_P \cdot (5/27) \cdot (1+\delta_m)$, where n counts discrete logarithmic Haar shells, j labels $SU(2)$ fiber irreps, V_P are the paradigm volumes $\{2, 2\pi, 2\pi^2\}$, and δ_m is the exact vista correction derived from kernel curvature (identical to the δ term in the α prediction). Dark-matter halos are the same mascons viewed in the pure Haar regime. No new particles, no vacuum density scale, no free parameters. The framework closes the gap between the macroscopic two-measure cosmology and the microscopic particle-core structure of nonzero quaternions, restoring strict geometric consistency across all scales.

1 Introduction

Hyperhamiltonian quantum mechanics (HHQM) [1,2,3] is based an Observer-theoretic framework with the "possible worlds semantics" and produces GR-friendly description of quantum systems whose state space is a hyperkähler manifold fibered over the Lie group of nonzero quaternions $H^\circ \simeq SU(2) \times \mathbb{R}^+$, forced by a demand that the Observer's logic is bevalent Boolean. Each fiber (a possible world) is a smooth real four dimensional manifold with a natural closed FLRW metric generated by the quaternionic structure, and two natural measures, Haar measure generated by the multiplicative Lie group structure, and Lebesgue

measure induced by the FLRW metric. We also obtain two sets of naturally preferred nonmetric directions (vistas) in spacetime (integral curves of left and right invariant vector fields). Each fiber can be visualized as an hourglass (imbedded in a higher dimensional Minkowski space, flaring toward Past and Future).

The dynamics in HHQM is constructed as a hyperhamiltonian flow (superposition of three Hamiltonian flows) in the hyperquantum bundle (monocosm), with the propensity metric (measuring distance between possible worlds) as it's main dynamical variable. A physical system in this framework is a fine-graining of a cosmology (a fiber $H^\circ \simeq SU(2) \times \mathbb{R}^+$, plus extra structures). Thus physical systems are described by the closed FLRW metric only, in any. Since closed FLRW is smooth and nondegenerate everywhere, physical systems are singularity free in this framework. Moreover, since the metric appeared naturally from the Observer-theoretic setup, HHQM neither uses nor needs Einstein Equations. Closed FLRW is simple but dynamical richness is guaranteed by the sophisticated transverse (orthogonal to possible worlds, the fibers) geometry of the monocosm.

The Standard Complex Quantum Mechanics (with antihermitian operators) emerges as a degenerate case of HHQM, with two (out of four) dimensions collapsed in each possible world, converting it back to a complex ray, and destroying the spacetime structure.

In the cosmological limit, the interplay of the Haar (left-invariant) structural measure μ and the Lebesgue (metric) measure λ on spacetime in HHQM naturally accounts for dark energy, the baryon-to-dark-matter ratio, late-time suppression of structure growth, and the precise value of the fine-structure constant α [4].

The microscopic limit, however, has remained open: how does the same two-measure tension near the quaternionic origin $0 \in H$ (where μ diverges logarithmically while λ remains finite) generate localized, particle-like objects with finite observable masses? Earlier explorations [5] identified a particle-core intuition (Haar-dominated regime, propensity collapse, surviving $SU(2)$ rotational structure) but left the absolute mass scale undetermined and introduced auxiliary parameters.

This note resolves both issues. We define the **mascon** as the natural, stable fixed-point configuration where Haar–Lebesgue imbalance is balanced against the visibility kernel at the universal geometric scale $r^* = e^{-1}$. All observable masses, baryonic densities, and dark-matter halos then follow from a single integral over the same kernel $K(x)$ that already fixes $\kappa = 10/9$ and the vista correction δ in the cosmological paper [4]. The result is a fully parameter-free mass spectrum that unifies the microscopic and macroscopic regimes.

2 Two-Measure Framework (Recap)

On H° the Haar measure satisfies $d\mu/d\lambda = r^{-4}$ (canonical coordinates $r = | q |$). Near the origin ($r \to 0$) this produces three regimes [5]:

- Regime I ($r \sim 1$): measures comparable (cosmological scale).
- Regime II ($r \ll 1$): Haar dominates, $\mu(B_\varepsilon) \sim \ln(1/\varepsilon)$ (logarithmic divergence).
- Regime III ($r = 0$): excluded improper viewpoint.

The FLRW scale factor and propensity metric g balance the divergence at an effective core radius $r_{\text{eff}} \approx r^*$, where the crossover visibility kernel

$$K(x) = \Sigma(x) \cdot \Pi_{\text{time}}, \Sigma(x) = \frac{x}{(1+x)^2}, x = \chi/\chi_s, \Pi_{\text{time}} = 1/2$$

peaks exactly as in the cosmological construction [4]. The normalized propensity distribution for the observable sector is

$$p(x) = \frac{4}{(1+x)^5}, \mu = 1/3, \sigma^2 = 2/9.$$

3 Dark Matter and Visible Matter (Cosmological Limit)

As derived in [4], the dark-sector density is $\rho_{\text{DM}}(\chi) = C/[\chi(\chi + \chi_s)^3]$ (finite enclosed mass $M_{\text{DM}} = 2\pi C/\chi_s$). Visible baryons arise from the kernel overlap:

$$\rho_b(\chi) = \kappa\Sigma(x)\rho_{\text{DM}}(\chi), \qquad \kappa = 10/9,$$

yielding $\Omega_{\text{DM}}/\Omega_b \approx 5.4$ with zero free parameters. The same kernel supplies the leading geometric term $4\pi^3 + \pi^2 + \pi$ and the quadratic vista correction δ for fine-structure constant α^{-1}.

4 Definition of a Mascon

A **mascon** is a localized, stable defect of measure equivalence: a region $\mathcal{M} \subset H^\circ$ in the hyperquantum bundle where

1. Haar excess $\Delta(r) = \mu(B_r)/\lambda(B_r) \gg 1$ inside the core,
2. propensity saturates ($\rho(\phi, \psi) \to 0$ as $r \to 0$),
3. finite observable coupling $K(x) \neq 0$ at the boundary $x \approx 1$.

- Deep core ($r \ll r^*$): pure Haar → invisible (dark sector).

- Crossover shell ($r \approx r^*$): $K(x)$ maximum → observable particle.
- Exterior ($r \gg r^*$): Lebesgue-dominated → classical propagation.

This is precisely the "particle core" anticipated in [5] (vista degeneration to pure $SU(2)$ rotational structure, scale-invariant internal frequency ω). Stability follows variationally from the HHQM Hamiltonian constraint plus the structure-field term $\lambda = \dot{R}/R$.

5 Explicit Mascon Mass Spectrum

The raw geometric defect per mascon consists of n discrete logarithmic Haar shells (stable fixed points of the renormalization flow $\beta(r) = d\ln\,(d\mu/d\lambda)/d\ln\, r = -4$) each carrying unit Haar weight at $r^* = e^{-1}$. Internal structure survives as the $S^3 \simeq SU(2)$ fiber; irreducible representations are labeled by half-integer j with multiplicity $2j + 1$. The three natural paradigms (R , C, H) realize the fiber volumes already appearing in the leading α term:

$$V_{\mathrm{R}} = 2, V_{\mathrm{C}} = 2\pi, V_{\mathrm{H}} = 2\pi^2.$$

Raw (invisible) defect:

$$M_{\mathrm{raw,\,n,j,P}} = n \cdot (2j + 1) \cdot V_P.$$

Observable mass is the defect weighted by the **same** kernel integral that fixes cosmological $\kappa = 10/9$:

$$m_{\mathrm{obs,\,n,j,P}} = M_{\mathrm{raw,\,n,j,P}} \cdot \mathcal{I}_K \cdot (1 + \delta_m),$$

where the leading visibility factor is the normalized crossover integral

$$\mathcal{I}_K = \frac{\kappa}{6} = \frac{5}{27}$$

(exact, from the same enclosed-mass spherical integration used for M_{DM} and M_b).

The higher-order vista correction δ_m is obtained identically to δ in [4] §8. Taylor expansion of $\Sigma(x)$at $x = 1$:

$$\Sigma''(1) = -\frac{1}{8}.$$

With the same propensity variance $\sigma^2 = 2/9$,

$$\delta_m = \frac{1}{2}\Sigma''(1) \cdot \sigma^2 \cdot \frac{V_P}{V_{\text{leading}}} = -\frac{1}{16} \cdot \frac{2}{9} \cdot \frac{V_P}{V_{\text{leading}}}.$$

Full explicit spectrum (no free parameters, no ρ_{vac}):

$$m_{n,j,P} = n(2j+1)V_P \cdot \frac{5}{27} \cdot (1+\delta_m).$$

Generation hierarchy arises naturally as volume jumps $1:\pi:\pi^2$ (R → C → H paradigms). Dark-matter mascons are pure H-paradigm cores (visibility factor omitted); their ensemble average exactly reproduces the ρ_{DM} profile of [4].

6 Unification and Dynamics

- **Baryons** = mascons precisely at the crossover ($x = 1$) → ρ_b and $\kappa = 10/9$ recovered identically.
- **Dark matter** = sub-crossover mascons (Haar-dominated halos) → extended ρ_{DM} profile.
- **Mass spectrum, α, and $\Omega_{\text{DM}}/\Omega_b$** share the identical kernel $K(x)$ and vista correction δ_m.
- **Dynamics**: mascon evolution follows the variational flow

$$\frac{dr_0}{dt} = -\frac{\partial}{\partial r}\left(\frac{d\mu}{d\lambda} \cdot K(x)\right)$$

derived from the HHQM Hamiltonian constraint. It guarantees stability at r^*, natural decay channels (paradigm/j-level transitions), and interactions—all governed by the same vista equations [5].

7 Conclusion and Predictions

Matter is a defect of measure equivalence at the quaternionic origin. The Mascon is the inevitable, stable configuration where the two natural measures on H° cannot be identified; when observed through the directed time projection $\Pi_{\text{time}} = 1/2$, it produces baryons, dark-matter halos, and the entire particle mass spectrum from one geometric object. All quantities are fixed by the universal crossover $r^* = e^{-1}$ and the kernel $K(x)$, restoring strict parameter-free consistency across microscopic and cosmological scales.

Key predictions (falsifiable with current and upcoming data):

• Mass ratios are exact rational multiples involving powers of π plus explicit δ_m-style vista corrections (e.g., charged-lepton/neutrino ratio $\approx \pi$).

• Generation structure follows volume hierarchy $1 : \pi : \pi^2$.

• Dark matter consists of the same mascons (deeper Haar regime) — no new particle species.

• Suppressed $f\sigma_8(z)$, reduced lensing, enhanced ISW (identical to [4] §6).

• Upward refinement of α^{-1} and microscopic mass ratios testable by next-generation spectroscopy and nuclear clocks.

The framework requires no additional assumptions beyond the HHQM monocosm already present in [1–5]. It offers a unified, geometric interpretation of the origin of all observable matter.

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