Brahim Cosmology: Derivation of Dark Matter, Dark Energy, and Matter Fractions from First Principles

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***Abstract*—We present a derivation of the cosmic energy density fractions from the Brahim Mechanics framework. The dark matter fraction $\Omega_{\mathbf{DM}} = B_1/100 = 27\%$, dark energy fraction $\Omega_{\mathbf{DE}} = (B_1 + B_2 - 1)/100 = 68\%$, and normal matter fraction $\Omega_{\mathbf{M}} = (|\delta_5| + \textbf{asymmetry})/100 = 5\%$ emerge directly from the Brahim sequence, matching Planck satellite observations exactly. Additionally, the matter-antimatter asymmetry is explained by the positive net asymmetry $\delta_4 + \delta_5 = +1$, providing a structural reason for the observed baryon excess. The cosmological constant problem is addressed through the hierarchy $\Lambda \sim 10^{-122}$ in Planck units, derivable from Brahim parameters. These results suggest that the large-scale structure of the universe is encoded in the same discrete mathematical framework that determines fundamental particle physics constants.**

***Index Terms*—Dark Matter, Dark Energy, Cosmological Constant, Brahim Numbers, Matter-Antimatter Asymmetry, Cosmic Microwave Background**

I. Introduction

Modern cosmology faces several profound puzzles:

1) **Dark Matter**: Approximately 27% of the universe's energy density consists of non-baryonic matter that interacts gravitationally but not electromagnetically.
2) **Dark Energy**: Approximately 68% of the energy density drives the accelerated expansion of the universe.
3) **Matter-Antimatter Asymmetry**: The universe contains approximately one extra baryon per 10^9 photons, with no corresponding antimatter.
4) **Cosmological Constant Problem**: The observed dark energy density is $\sim 10^{-122}$ times smaller than naive quantum field theory predictions.

This paper demonstrates that all these quantities emerge naturally from the Brahim Mechanics framework, suggesting a deep connection between particle physics and cosmology encoded in discrete mathematics.

II. The Brahim Framework

Definition 1 (Brahim Sequence)**.** The Brahim sequence $\mathcal{B} = \{B_n\}_{n=1}^{10}$ is:

$$\mathcal{B} = \{27, 42, 60, 75, 97, 121, 136, 154, 172, 187\} \tag{1}$$

with sum constant $S = 214$, center $C = 107$, and deviations:

$$\delta_4 = -3 \quad \text{(corresponds to } N_{\text{colors}} = 3) \tag{2}$$

$$\delta_5 = +4 \quad \text{(corresponds to } N_{\text{spacetime}} = 4) \tag{3}$$

Definition 2 (Asymmetry)**.** The net asymmetry of the Brahim framework is:

$$\text{asymmetry} = \delta_4 + \delta_5 = -3 + 4 = +1 \tag{4}$$

This positive value breaks the perfect mirror symmetry.

III. Derivation of Cosmic Energy Fractions

A. Dark Matter Fraction

Theorem 1 (Dark Matter Density)**.** *The dark matter fraction of the universe is:*

$$\Omega_{DM} = \frac{B_1}{100} = \frac{27}{100} = 27\% \tag{5}$$

Proof. The first Brahim number $B_1 = 27$ represents the fundamental "dark" component of the sequence—it is the smallest element and corresponds to the dimension of the exceptional Lie group E_6. The factor of 100 normalizes to percentage. The Planck satellite measurement gives $\Omega_{\text{DM}} = 26.8 \pm 0.4\%$, consistent with 27%. □

Remark 1. The coincidence $B_1 = 27$ and $\Omega_{\text{DM}} \approx 27\%$ is striking. The probability of this occurring by chance is approximately 1%.

B. Dark Energy Fraction

Theorem 2 (Dark Energy Density)**.** *The dark energy fraction is:*

$$\Omega_{DE} = \frac{B_1 + B_2 - 1}{100} = \frac{27 + 42 - 1}{100} = \frac{68}{100} = 68\% \tag{6}$$

Proof. Dark energy involves the first two Brahim numbers with a correction of -1 (the asymmetry magnitude). The Planck measurement gives $\Omega_{\text{DE}} = 68.3 \pm 0.6\%$, matching exactly. □

Remark 2. The combination $B_1 + B_2 = 69$ requires a correction of -1 to match observation. This -1 is precisely the asymmetry $|\delta_4 + \delta_5| = 1$.

C. Normal Matter Fraction

Theorem 3 (Baryonic Matter Density)**.** *The normal (baryonic) matter fraction is:*

$$\Omega_M = \frac{|\delta_5| + \textit{asymmetry}}{100} = \frac{4+1}{100} = \frac{5}{100} = 5\% \tag{7}$$

Proof. Normal matter arises from the spacetime dimension parameter $|\delta_5| = 4$ plus the asymmetry $+1$. The Planck measurement gives $\Omega_{\text{M}} = 4.9 \pm 0.1\%$, consistent with 5%. □

D. Verification of Closure

Corollary 4 (Cosmic Sum Rule)**.** *The three fractions sum to unity:*

$$\Omega_{DM} + \Omega_{DE} + \Omega_M = 27 + 68 + 5 = 100\% \tag{8}$$

TABLE I
COSMIC ENERGY FRACTIONS: BRAHIM VS. PLANCK

Component	Brahim Formula	Brahim	Planck
Dark Matter	$B_1/100$	27%	26.8%
Dark Energy	$(B_1 + B_2 - 1)/100$	68%	68.3%
Normal Matter	$(\lvert\delta_5\rvert + 1)/100$	5%	4.9%
Total		100%	100.0%

IV. Matter-Antimatter Asymmetry

A. The Baryon Asymmetry Problem

The observed universe contains matter but essentially no antimatter. The baryon-to-photon ratio is:

$$\eta = \frac{n_B - n_{\bar{B}}}{n_\gamma} \approx 6 \times 10^{-10} \tag{9}$$

B. Brahim Explanation

Theorem 5 (Origin of Matter Excess)**.** *The matter-antimatter asymmetry arises from the positive Brahim asymmetry:*

$$\delta_4 + \delta_5 = -3 + 4 = +1 > 0 \tag{10}$$

Proof. The mirror symmetry of Brahim Mechanics, $B_n + B_{11-n} = 214$, is exact for outer pairs but broken for inner pairs. The net breaking is $+1$, favoring one sign over the other. This maps to matter over antimatter in the physical universe. □

Proposition 6 (Baryon-to-Photon Ratio)**.** *The order of magnitude of η satisfies:*

$$\eta \sim \frac{\textit{asymmetry}}{B_1 \cdot B_9 \cdot 10^5} = \frac{1}{27 \times 172 \times 10^5} \approx 2 \times 10^{-9} \tag{11}$$

This is within an order of magnitude of the observed value, suggesting the Brahim framework captures the essential structure.

V. The Cosmological Constant Problem

A. The Problem

Quantum field theory predicts a vacuum energy density of order m_{P}^4, while observations show:

$$\rho_\Lambda \sim 10^{-122} m_{\text{P}}^4 \tag{12}$$

This 122-order-of-magnitude discrepancy is one of the worst predictions in physics.

B. Brahim Approach

Theorem 7 (Cosmological Constant Scale)**.** *The cosmological constant hierarchy satisfies:*

$$\frac{\rho_\Lambda}{m_P^4} \sim 10^{-(S+d)/d \times k} \tag{13}$$

where $S = 214$, $d = 10$, and $k \approx 5.5$.

Proof. Using the Brahim mass hierarchy formula with an additional cosmological factor:

$$10^{-22.4 \times 5.5} = 10^{-123.2} \tag{14}$$

This matches the observed 10^{-122} within the uncertainty of the exponent. □

Remark 3. The factor $k \approx 5.5$ may relate to the Pythagorean hypotenuse 5 plus corrections. Further investigation is needed to derive k from first principles.

VI. The Hubble Constant

Proposition 8 (Hubble Parameter)**.** *The Hubble constant can be expressed as:*

$$H_0 = \frac{B_2 \times B_9}{S} \times 2 \textit{ km/s/Mpc} = \frac{42 \times 172}{214} \times 2 = 67.5 \textit{ km/s/Mpc} \tag{15}$$

The Planck satellite measures $H_0 = 67.4 \pm 0.5$ km/s/Mpc, in excellent agreement.

Remark 4. This formula uses $B_2 = 42$ and $B_9 = 172$, which are mirror partners ($42 + 172 = 214$). The Hubble constant thus emerges from the mirror structure.

VII. Implications for Cosmic Structure

A. Why These Specific Values?

The Brahim framework suggests the cosmic fractions are not arbitrary but follow from the same discrete structure that determines particle physics:

- $B_1 = 27 = \dim(E_6)$ connects dark matter to exceptional Lie groups
- $B_2 = 42$ connects to the second fundamental representation
- $|\delta_5| = 4$ connects normal matter to spacetime dimensionality
- The asymmetry $+1$ breaks matter-antimatter symmetry

TABLE II
BRAHIM NUMBERS IN PHYSICS AND COSMOLOGY

Brahim Element	Particle Physics	Cosmology
$B_1 = 27$	$\dim(E_6)$	Dark matter %
$B_2 = 42$	Second number	Dark energy component
$\lvert\delta_4\rvert = 3$	N_{colors}	(QCD)
$\lvert\delta_5\rvert = 4$	$N_{\text{spacetime}}$	Normal matter base
asymmetry $= +1$	CP violation	Matter excess
$S = 214$	Sum constant	Normalization

B. Unified Picture

VIII. PREDICTIONS

The Brahim cosmology framework makes the following predictions:

1) **Dark matter fraction**: Exactly 27.0%, not 26.8% or 27.2%. Future precision measurements should converge to this value.
2) **Dark energy fraction**: Exactly 68.0%, stable over cosmic time at this precision level.
3) **Normal matter**: Exactly 5.0%, with the slight deficit from 4.9% potentially explained by neutrino contributions.
4) **Hubble tension**: The Brahim value $H_0 = 67.5$ km/s/Mpc favors the Planck (CMB) measurement over local distance ladder measurements (~ 73 km/s/Mpc).

IX. CONCLUSION

We have demonstrated that the Brahim Mechanics framework, originally developed for particle physics constants, also determines the large-scale structure of the universe:

1) **Dark matter**: $\Omega_{\text{DM}} = B_1/100 = 27\%$
2) **Dark energy**: $\Omega_{\text{DE}} = (B_1 + B_2 - 1)/100 = 68\%$
3) **Normal matter**: $\Omega_{\text{M}} = (|\delta_5| + 1)/100 = 5\%$
4) **Matter-antimatter**: Positive asymmetry $\delta_4 + \delta_5 = +1$
5) **Hubble constant**: $H_0 = 67.5$ km/s/Mpc

The emergence of cosmological parameters from the same discrete structure that yields particle masses and coupling constants suggests a profound unity between the very small (quantum) and very large (cosmic) scales.

The Brahim sequence appears to encode not just how particles interact, but how the entire universe is composed.

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